HEWLETT PACKARD

Service Manual

HP 54120B
Digitizing Oscilloscope
Mainframe

Math

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: HP 54120B
Date Printed: July 1989
Part Number: 54120-90908

This supplement contains important information for correcting errors in the manual and for adapting the manual to instruments containing improvements that were made after the printing of the manual.

To use this supplement:
Make all ERRATA corrections.
Make all appropriate serial number related changes indicated in the table.

Serial Prefix	Make Manual Changes	Serial Prefix	Make Manual Changes
2944A	1		
3008A	1, 2		
3012A	1, 2, 3		
3035A	1, 2, 4,		
3051A	1, 2, 4, 5		
3149A	1, 2, 4, 5, 6		

♦ NEW ITEM

Errata

This errata inclusion provides a drawing for the Replaceable Parts section to help you locate cables in the mainframe. The Table of Contents page is also updated.

Replace the Contents-5 page with the page in this document.
Add page 5-11 to the end of the Replaceable Parts section.

Change 1

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A14 changed to HP part number 2090-0226 Color CRT Module.
MP13, right side cover 5061-9523, was removed from the Replaceable Parts list.
MP12, MP14, MP15, and MP16, changed in quantity from 1 to 2.

Note

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies, quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

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Change 2

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A2 changed to HP part number 54111-66527, CD = 7
*A2 changed to HP part number 54111-69527, CD = 3

Change 3

The part number of the A11 assembly was changed as indicated below. However, the A11 assembly was changed again to a new part number in change 4. Therefore, you will find the change 4 part numbers for the A11 assembly in the replaceable parts list.

A11 changed to HP part number 54110-66515, CD = 2
*A11 changed to HP part number 54110-69515, CD = 8

Change 4

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A11 changed to HP part number 54110-66516, primary power supply assembly.

Change 5

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

This prefix change covers changes to PC assemblies that are transparent at the assembly replacement level of maintenance.

♦ **Change 6**

Replace: Title page, Printing History pages iii and iv, Replaceable Parts pages 5-8, 5-9, and 5-10.

A14 changed to HP part number 2090-0251, CD = 6
H7 was added, HP part number 54110-1214, Hex Nut, Qty = 4, CD = 3
MP13 was added, HP part number 54111-00608, Display Shield, Qty = 1, CD = 7
MP30 changed to HP part number 54110-1214, CD = 2
MP31 changed to HP part number 54110-1215, CD = 3

HEWLETT PACKARD

Service Manual

HP 54120B

Digitizing Oscilloscope Mainframe

Serial Numbers

This manual applies directly to instruments prefixed with serial number:

3149A

With changes described within, this manual also applies to instruments with serial prefixes:

3051A
3035A
3012A
3008A
2944A
2926A
2909A

For Additional Information about serial numbers see Instruments Covered by This Manual in Section 1.

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Manual Part No. 54120-90908
Microfiche Part No. 54120-90808

Printed in U.S.A.: July 1989
Updated: January 8, 1992

Herstellerbescheinigung

Hiermit wird bescheinigt, dass das Gerät/System HP 54120B in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte

Werden Mess- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funkentstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this product HP 54120B meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

Additional Information for Test and Measurement Equipment

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must insure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software and/or firmware code may be printed before the date; this indicates the version level of the software and/or firmware of this product at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

Edition 1	July 1989	54120-90908
Update 1	October 1989	54120-90908
Update 2	February 1990	54120-90908
Update 3	March 1990	54120-90908
Update 4	August 1990	54120-90908
Update 5	January 1991	54120-90908
Update 6	March 1991	54120-90908
Update 7	January 1992	54120-90908

List of Effective Pages

The List of Effective Pages gives the date of the current edition and of any pages changed in updates to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. If an update is incorporated when a new edition of the manual is printed, the change dates are removed from the bottom of the pages and the new edition date is listed in Printing History and on the title page.

Pages	Effective Date
all	July 1989
Title page, iii, iv, 5-8, 5-9	October 1989
Title page, iii, iv, 5-8	February 1990
Title page, iii, iv, 5-8	March 1990
Title page, iii, iv, 5-8	August 1990
Title page, iii, iv, 5-8, and 5-9	January 1991
Contents-5, 5-11	March 1991
Title page, iii, iv, 5-8, 5-9, and 5-10	January 1992

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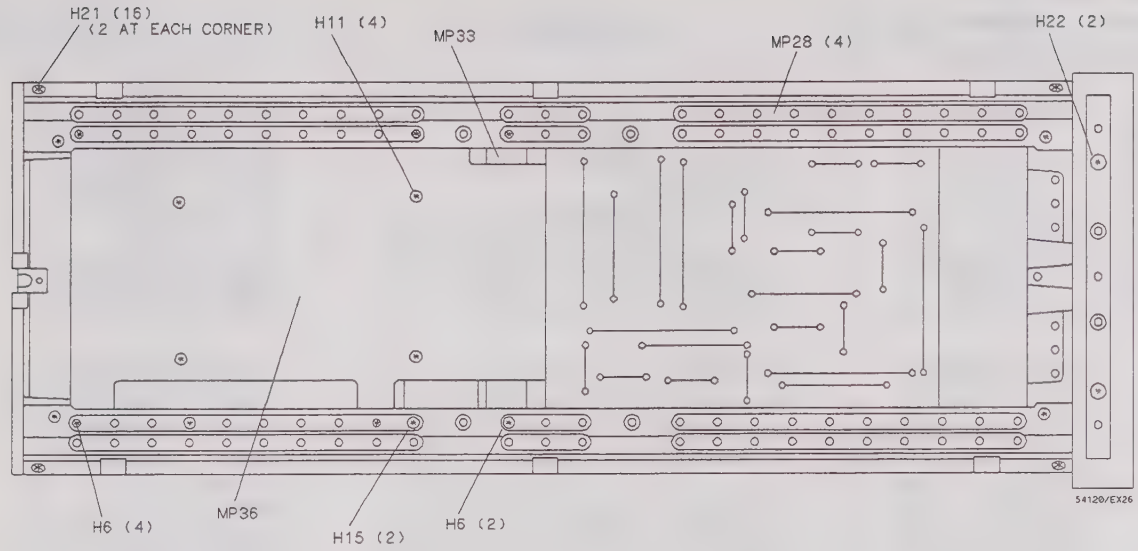

Figure 5-5. Left Side View

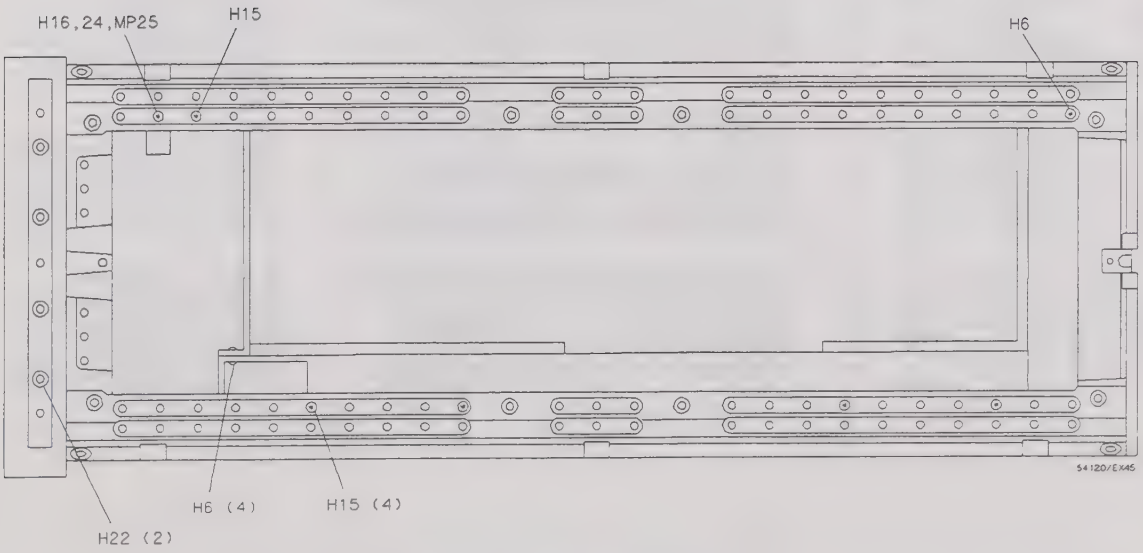

Figure 5-6. Right Side View

Table 5-3. Replaceable Parts List

Reference Designator	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
*EXCHANGE ASSEMBLIES						
*A1	54111-69506	8	0	I/O ASSEMBLY	28480	54111-69506
*A2	54111-69527	3	0	MICROPROCESSOR ASSEMBLY	28480	54111-69527
*A3	54122-69501	6	0	HORIZONTAL CONTROL ASSEMBLY	28480	54122-69501
*A4	54120-69502	5	0	ADC ASSEMBLY	28480	54120-69502
*A6	54110-69514	7	0	COLOR DISPLAY ASSEMBLY	28480	54110-69514
*A11	54110-69516	3	0	PRIMARY POWER SUPPLY ASSEMBLY	28480	54110-69516
*A12	54110-69510	3	0	ANALOG POWER SUPPLY ASSEMBLY	28480	54110-69510
*A13	54110-69506	7	0	DIGITAL POWER SUPPLY ASSEMBLY	28480	54110-69506
A1	54111-66506	2	1	I/O ASSEMBLY	28480	54111-66506
A2	54111-66527	7	1	MICROPROCESSOR ASSEMBLY	28480	54111-66527
A3	54122-66501	0	1	HORIZONTAL CONTROL ASSEMBLY	28480	54122-66501
A4	54120-66502	9	1	ADC ASSEMBLY	28480	54120-66502
A5	54110-66511	8	1	MOTHER BOARD ASSEMBLY	28480	54110-66511
A6	54110-66514	1	1	COLOR DISPLAY ASSEMBLY	28480	54110-66514
A7	54110-66509	4	1	CRT CONTROL ASSEMBLY	28480	54110-66509
A8	54100-66520	7	1	MENU KEYBOARD	28480	54100-66520
A9	54110-66502	7	1	FUNCTION KEYBOARD	28480	54110-66502
A10	54100-66505	8	1	CONTROL KEYBOARD	28480	54100-66505
A11	54110-66516	9	1	PRIMARY POWER SUPPLY ASSEMBLY	28480	54110-66516
A12	54110-66510	7	1	ANALOG POWER SUPPLY ASSEMBLY	28480	54110-66510
A13	54110-66506	1	1	DIGITAL POWER SUPPLY ASSEMBLY	28480	54110-66506
A14	2090-0251	6	1	COLOR CRT MODULE	28480	2090-0251
A15	01980-61062	5	1	RPG ASSEMBLY	28480	01980-61062
B1	3160-0521	3	1	FAN-TUBEAXIAL	28480	3160-0521
E1	8160-0577	4	1	RFI GROUND STRIP	28480	8160-0577
H1	0515-1384	8	2	SCREW-MACH M5 X 0.8 10MM-LG	28480	0515-1384
H2	0515-1444	1	4	SCREW-MACH M3.5 X 0.6 25.4MM-LG PAN-HD	28480	0515-1444
H3	0515-1319	9	8	SCREW-MACH M3 X 0.5 20MM-LG PAN-HD	28480	0515-1319
H4	1251-2942	7	2	SCREW LOCK KIT-SUBMIN D CONN	28480	1251-2942
H5	1251-1245	7	3	COVER SCREW	28480	1251-2945
H6	0515-0372	2	49	SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG	28480	0515-0372
H7	0535-0066	3	4	HEX NUT	28480	0535-0066
H8	0515-1253	0	3	RETAINER RING FOR COVER SCREW2	8480	0515-1253
H9	0515-1444	1	4	FOOT SCREW	28480	0515-1444
H10	0515-1410	1	7	SCREW-MACHINE ASSEMBLY M3 X 0.5 20MM-LG	28480	0515-1410
H11	0515-1025	4	4	SCREW-MACHINE ASSEMBLY M3 X 0.5 26MM-LG	28480	0515-1025
H12	5061-6138	2	4	NUT-INSERT M4 X 0.7 X 4.6 OD	28480	5061-6138
H13	2190-0763	7	2	WASHER-FL MTLC NO. 6 .14-IN-ID .5-IN-OD	28480	2190-0763
H14	3050-1238	8	2	WASHER-FL NM 9/64 .149-IN-ID .478-IN-OD	86928	3050-1238
H15	0515-0433	6	15	SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-0433

Table 5-3. Replaceable Parts List

Reference Designator	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
H16	NOT ASSIGNED					
H17	0515-0641	8	2	SCREW-THD-RLG M4 X 0.7 10MM-LG PAN-HD	28480	0515-0641
H18	0515-0435	8	4	SCREW-MACHINE ASSEMBLY M4 X 0.7 14MM-LG	28480	0515-0435
H19	NOT ASSIGNED					
H20	0515-1228	9	4	SCREW-MACH M4 X 0.7 6MM-LG 90-DEG-FLH-HD	28480	0515-1228
H21	0515-1403	2	16	SCREW-SPCL M4 X 0.7 6MM-LG 90-DEG-FLH-HD	28480	0515-1403
H22	0515-1269	8	16	SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-1269
H23	0535-0031	2	9	NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK	28480	0535-0031
H24	NOT ASSIGNED					
H25	2950-0043	8	1	NUT-HEX-DBL-CHAM 3/82THD .094-IN-THK	28480	2950-0043
H26	0380-1686	6	2	STANDOFF-HEX 6.5-MM-LG M3 X 0.5-THD	28480	0380-1686
H27	2190-0016	3	1	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
H28	3050-1176	3	1	WASHER-FL NM 3/8 IN .39-IN-ID .562-IN-OD	86928	3050-1176
H29	0515-0664	5	5	SCREW M3 12MN-L6 PAN-HP T10	28480	0515-0664
MP1	01650-47401	7	1	RPG KNOB	28480	01650-47401
MP2	5061-9448	3	1	BOTTOM COVER	28480	5061-9448
MP3	5040-7201	8	2	BOTTOM FEET	28480	5040-7201
MP4	5040-7222	3	2	BOTTOM NON SKID FEET	28480	5040-7222
MP5	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP6	8160-0590	1	2	GROUND RFI STRIP	28480	8160-0590
MP7	54110-04103	4	1	TOP COVER	28480	54110-04103
MP8	0890-0029	0	1	TUBING-HS .187-IN-D/.093-IN-RCVD	28480	0890-0029
MP9	5001-0441	2	2	TRIM STRIP SIDE	28480	5001-0441
MP10	5040-7202	9	1	TOP TRIM STRIP	28480	5040-7202
MP11	54110-40502	3	4	REAR FOOT	28480	54110-40502
MP12	5060-9948	6	2	SIDE COVERS—PERFORATED	28480	5060-9948
MP13	54111-00608	7	1	DISPLAY SHIELD	28480	54111-00608
MP14	5060-9805	4	2	STRAP HANDLE	28480	5060-9805
MP15	5041-6819	4	2	FRONT CAP FOR STRAP HANDLE	28480	5041-6819
MP16	5041-6820	7	2	REAR CAP FOR STRAP HANDLE	28480	5041-6820
MP17	NOT ASSIGNED					
MP18	5021-5807	6	1	FRONT FRAME	28480	5021-5807
MP19	54120-00206	2	1	FRONT PANEL	28480	54120-00206
MP20	54111-00203	8	1	FRONT SUB PANEL	28480	54111-00203
MP21	54110-40501	2	1	DISPLAY BEZEL	28480	54110-40501
MP22	16500-00603	3	1	FAN SCREEN	28480	16500-00603
MP23	0403-0092	6	1	BUMPER FOOT-PRS-IN	28480	0403-0092
MP24	1400-1362	0	2	CLAMP-CABLE .35-DIA .51-WD NYL	28480	1400-1362
MP25	1400-0611	0	2	CLAMP-FL-CA 1-WD	06915	1400-0611
MP26	54111-01203	0	1	FRONT CARD CAGE BRACKET	28480	54111-01203
MP27	54111-00101	5	1	MAIN DECK	28480	54111-00101
MP28	5021-5838	3	4	SIDE STRUT	28480	5021-5838
MP29	NOT ASSIGNED					
MP30	54110-01214	2	1	TOP CRT BRACKET	28480	54110-01214

Table 5-3. Replaceable Parts List

Reference Designator	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
MP31	54110-01215	3	1	BOTTOM CRT BRACKET	28480	54110-01215
MP32	54110-01210	8	1	BRACKET-COLOR CRT MOD. REAR-ON MODULE	28480	54110-01210
MP33	54110-04702	9	1	BRACKET-COLOR CRT MOD. REAR-ON FRAME	28480	54110-04702
MP34	1400-0679	0	4	CLIP-CABLE 'U' SHP, PNL MTG TYPE	28480	1400-0679
MP35	54111-04104	6	1	POWER SUPPLY COVER-TOP	28480	54111-04104
MP36	54110-04106	7	1	POWER SUPPLY COVER-SIDE	28480	54110-04106
MP37	5021-5808	7	1	REAR FRAME	28480	5021-5808
MP38	54110-94302	4	1	WARNING LABEL	28480	54110-94302
MP39	54120-00201	7	1	REAR PANEL	28480	54120-00201
MP40	54111-05201	6	1	AIR PLENUM	28480	54111-05201
MP41	7120-4835	0	1	LABEL-INFORMATION .75-IN-WD 2-IN-LG PPR	28480	7120-4835
MP42	3160-0092	3	1	FAN GUARD	28480	3160-0092
MP44	54120-04103	6	1	FAN COVER	28480	54120-04103
MP45	54120-04702	1	1	FAN SPACER	28480	54120-04702
S1	3101-2911	5	1	ROCKER SWITCH (STANDBY)	28480	3101-2911
W1	8120-1521	6	1	POWER CABLE	28480	8120-1521
W2	54100-61602	6	1	HPIB CABLE	28480	54100-61602
W3	54120-61618	8	1	UMBILICAL CABLE 2 METRE	28480	54120-61618
W4	54120-61612	2	1	MAINFRAME CABLE ASSEMBLY	28480	54120-61612
W5	54100-61601	5	1	RIBBONCABLE-I/O TO FRONT PANEL	28480	54100-61601
W6	54100-61612	8	2	CABLE AC BD CO ANAL & DIG BD	28480	54100-61612
W7	NOT ASSIGNED					
W8	54110-61601	7	1	3 WIRE CABLE - COLOR DISPLAY MODULE POWE	28480	54110-61601
W9	54111-61610	9	1	POWER SWITCH CABLE 2 WIRE-FRONT PANEL ST	28480	54110-61610
W10	54111-61611	0	1	2 WIRE CABLE-REAR CABLE STBY SWITCH	28480	54111-61611
W11	54110-61611	9	1	DISPLAY CONTROL CABLE	28480	54110-61611
W12	54110-61607	3	1	RIBBON CABLE DISP ASSY TO COLOR MODULE	28480	54110-61607

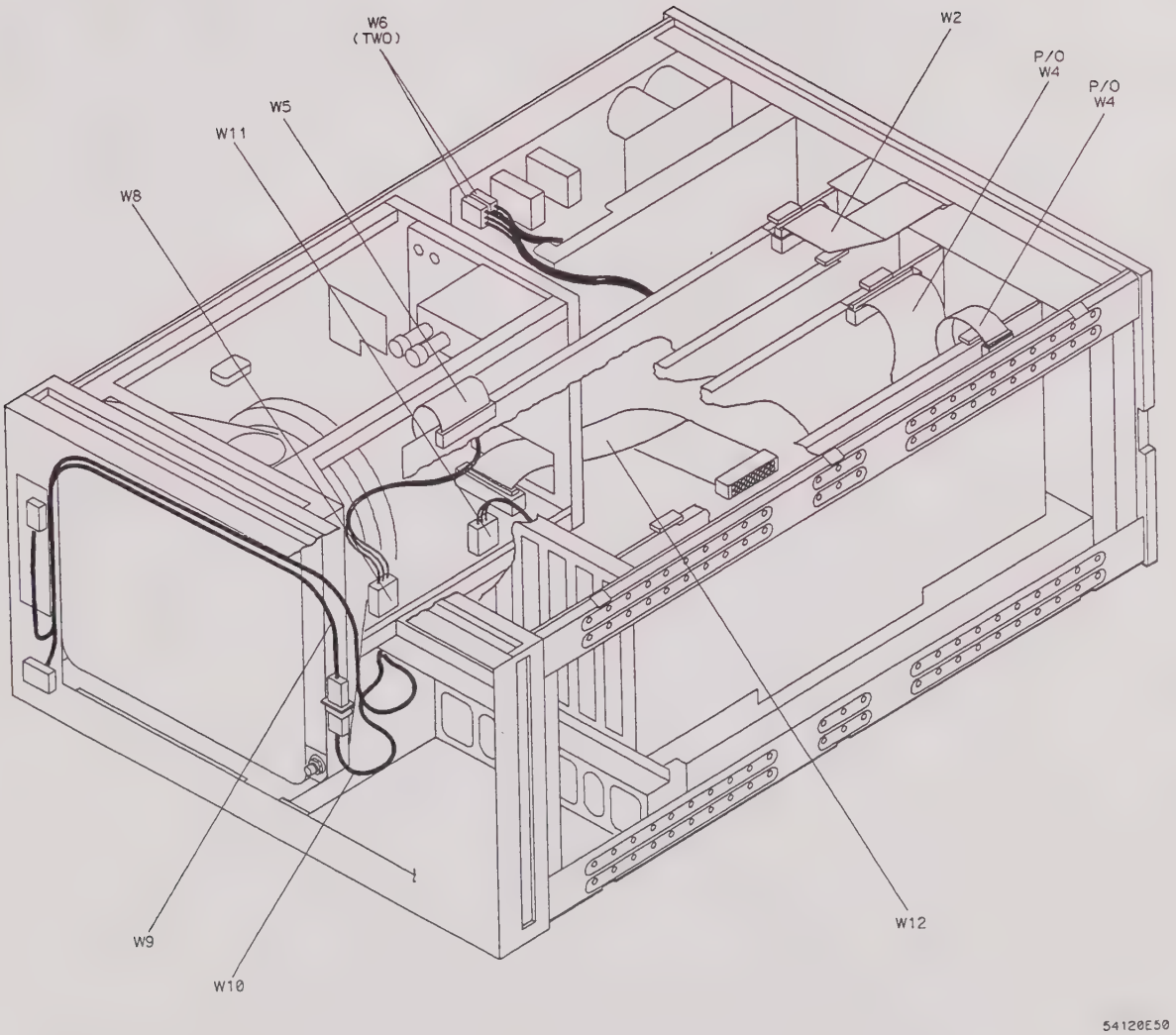

Figure 5-7. Mainframe Cable Locations

HEWLETT PACKARD

SERVICE MANUAL

HP 54120B

Digitizing Oscilloscope Mainframe

SERIAL NUMBERS

This manual applies directly to instruments prefixed with serial number:

2926A

With changes described within, this manual also applies to instruments with serial prefixes:

2909A

For Additional Information about serial numbers see INSTRUMENTS COVERED BY THIS MANUAL in Section 1.

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Manual Part No. 54120-90908
Microfiche Part No. 54120-90808

Printed in U.S.A.: July 1989

Herstellerbescheinigung

Hiermit wird bescheinigt, dass das Gerät/System HP 54120B in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte

Werden Mess- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funkentstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this product HP 54120B meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

Additional Information for Test and Measurement Equipment

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must insure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.

GEWERBEAUFSICHTSAMT STUTTGART

- Zentrale Stelle für Sicherheitstechnik und Vorschriftenwesen in Baden-Württemberg -

Gewerbeaufsichtsamt · Jägerstr. 89 · Postfach 703 · 7000 Stuttgart 1

Hewlett-Packard GmbH
Herrenberger Straße 110

7030 Böblingen

Stuttgart, den 02.06.1986
Fernsprecher
(0711) 8 05 01 (Behördenzentrum)
Durchwahl 2050 - 4798
Aktenzeichen: Z 5108/Hewlett-Packard/Ws/Vg
(Bitte bei Antwort angeben)

Betr.: Durchführung der Röntgenverordnung (RöV)
hier: Bauartzulassung gem. § 7 Abs. 2 RöV

Bezug: Ihr Antrag vom 22.05.1986; PSD US-ab

Nachtrag 1

zum Zulassungsschein Nr. BW/218/86/Rö

Aufgrund des § 7 Abs. 2 der Röntgenverordnung vom 1.3.1973 (BGBl. I S. 173) wird die der Firma Hewlett-Packard GmbH, Herrenberger Straße 110, 7030 Böblingen, erteilte Zulassung Nr. BW/218/86/Rö vom 16.01.1986 wie folgt erweitert:

Gegenstand:	Digital-Oszilloskop
Firmenbezeichnung:	HP Typ 54 111 D HP Typ 54 112 D HP Typ 54 120 A
Bauartunterlagen:	Service Manuals Nr. 54 111 - 90 902 vom 21.94.86 Nr. 54 112 - 90 902 vom 24.04.86 Nr. 54 120 - 90 902 vom 26.04.86

Die für den Strahlenschutz wesentlichen Merkmale entsprechen der bereits zugelassenen Ausführung.

Typenbezeichnung der Bildröhre, Auflagen, Hinweise und Befristung ergeben sich aus dem Zulassungsschein Nr. BW/218/86/Rö vom 16.01.1986.

Dieser Nachtrag gilt nur im Zusammenhang mit dem vollständigen Text des o.g. Zulassungsscheins.

Reutter

GEWERBEAUFSICHTSAMT STUTTGART

Dieses Gerät wurde nach den Auflagen der Zulassungsbehörde einer Stückprüfung unterzogen und entspricht in den für den Strahlenschutz wesentlichen Merkmalen der Bauartzulassung. Die Beschleunigungsspannung beträgt maximal 22,3 kV.

Hewlett-Packard
1900 Garden of the Gods Road
Colorado Springs
Colorado 80907, USA

GEWERBEAUFSICHTSAMT STUTTGART

- Zentrale Stelle für Sicherheitstechnik und Vorschriftenwesen in Baden-Württemberg -

Gewerbeaufsichtsamt · Jägerstr. 22 · Postfach 703 · 7000 Stuttgart 1

Stuttgart, den 16.01.1986

Fernsprecher
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Durchwahl 2050- 4798
Aktenzeichen: Z 5108/HP/Ws/Hh
(Bitte bei Antwort angeben)

Firma
Hewlett Packard GmbH
Herrenberger Str. 110/130

7030 Böblingen

Zulassungsschein Nr. BW/218/86/Rö

Gemäß § 9 der Röntgenverordnung vom 01.03.1973 (BGBl. I S. 173) wird die Zulassung der Bauart durch den Bauartzulassungsbescheid vom 16.01.1986 mit Aktenzeichen Z 5108/HP/Ws/Hh für den nachfolgend aufgeführten Störstrahler bescheinigt:

Gegenstand	:	Digital-Oszilloskop
Firmenbezeichnung	:	HP Typ 54110D
Bildröhre	:	Sony Typ M23 JHU 15X
Hersteller	:	Hewlett-Packard 1900 Garden of the Gods Road Colorado Springs Colorado 80907, USA
Betriebsbedingungen	:	Hochspannung: max. 22,3 kV Strahlstrom: max. 0,4 mA
Zulassungskennzeichen	:	BW/218/86/Rö

Die Bauartzulassung ist befristet bis 16.01.1996.

Für den Strahlenschutz wesentliche Merkmale

1. Die Art und Qualität der Bildröhre,
2. die der Hochspannungserzeugung und -stabilisierung dienenden Bauelemente.

Auflagen:

1. Die Geräte sind bezüglich der für den Strahlenschutz wesentlichen Merkmale entsprechend den vorgestellten und geprüften Mustern und Antragsunterlagen herzustellen.

2. Die Geräte sind einer Stückprüfung daraufhin zu unterziehen, ob sie bezüglich der für den Strahlenschutz wesentlichen Merkmale der Bauartzulassung entsprechen.

   Die Prüfung muß umfassen:

   a) Kontrolle der Hochspannung an jedem einzelnen Gerät,

   b) Messung und Dosisleistung nach Festlegung im Bauartzulassungsbescheid.

3. Die Herstellung und die Stückprüfung sind durch den von der Zulassungsbehörde bestimmten Sachverständigen überwachen zu lassen.

4. Die Geräte sind deutlich sichtbar und dauerhaft mit dem Kennzeichen

   BW/218/86/Rö

   zu versehen sowie mit einem Hinweis folgenden Mindestinhalts:

   "Die in diesem Gerät entstehende Röntgenstrahlung ist ausreichend abgeschirmt. Beschleunigungsspannung maximal 22,3 kV."

Hinweis für den Benutzer des Geräts:

Unsachgemäße Eingriffe, insbesondere Verändern der Hochspannung oder Auswechseln der Bildröhre können dazu führen, daß Röntgenstrahlung in erheblicher Stärke auftritt. Ein so verändertes Gerät entspricht nicht mehr dieser Zulassung und darf infolgedessen nicht mehr betrieben werden.

Reutter

GEWERBEAUFSICHTSAMT STUTTGART

Dieses Gerät wurde nach den Auflagen der Zulassungsbehörde einer Stückprüfung unterzogen und entspricht in den für den Strahlenschutz wesentlichen Merkmalen der Bauartzulassung. Die Beschleunigungsspannung beträgt maximal 22,3 kV.

Hewlett-Packard
1900 Garden of the Gods Road
Colorado Springs
Colorado 80907, USA

X-RAY RADIATION NOTICE

ACHTUNG Model 54111D/54112D/54120A **WARNING**

Während des Betriebs erzeugt dieses Gerät Röntgenstrahlung. Das Gerät ist so abgeschirmt, daß die Dosisleistung weniger als 36 pA/kg (0,5 mR/h) in 5cm Abstand von der Oberfläche der Katodenstrahlröhre beträgt. Somit sind die Sicherheitsbestimmungen verschiedener Länder, u.A. der deutschen Röntgenverordnung eingehalten.

Die Stärke der Röntgenstrahlung hängt im Wesentlichen von der Bauart der Katodenstrahlröhre ab sowie von den Spannungen, welche an dieser anliegen. Um einen sicheren Betrieb zu gewährleisten, dürfen die Einstellungen des Niederspannungs— und Hochspannungsnetzteils nur nach der Anleitung in Kapitel Einstellvorschriften des Service Handbuches vorgenommen werden.

Die Kathodenstrahlröhre darf nur durch die gleiche Type ersetzt werden. (Siehe Kapitel Ersatzteile für HP-Teilenummern.)

Das Gerä ist in Deutschland zugelassen unter

der Nummer: BW/218/86/ROE

When operating, this instrument emits x-rays; however, it is well shielded and meets safety and health requirements of various countries, such as the X-ray Radiation Act of Germany.

Radiation emitted by this instrument is less than 0.5 mR/hr at a distance of five (5) centimeters from the surface of the cathode-ray tube. The x-ray radiation primarily depends on the characteristics of the cathode-ray tube and its associated low-voltage and high-voltage circuitry. To ensure safe operation of the instrument, adjust both the low-voltage and high-voltage power supplies as outlined in the Adjustments Section of the Service Manual.

Replace the cathode-ray tube with an identical CRT only. Refer to the Replacement Parts Section for proper HP part number.

Number of German License: BW/218/86/ROE

X-RAY

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

CWA388

Safety Considerations

General Operation

This is a Safety Class I instrument (provided with terminal for protective earthing). BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage, the correct fuse is installed, and Safety Precautions are taken (see the following warnings). In addition, note the instrument's external markings which are described under "Safety Symbols."

General Warnings and Cautions

- BEFORE SWITCHING ON THE INSTRUMENT, the protective earth terminal of the instrument must be connected to the protective conductor of the (mains) powercord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.
- If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.
- Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.
- Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.
- Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.
- Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Safety Symbols

Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the product.

Indicates Hazardous Voltages

Earth terminal (sometimes used in manual to indicate circuit common connected to grounded chassis).

Warning

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Caution

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood or met.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software and/or firmware code may be printed before the date; this indicates the version level of the software and/or firmware of this product at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

Edition 1 July 1989 54120-90908

List of Effective Pages

The List of Effective Pages gives the date of the current edition and of any pages changed in updates to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. If an update is incorporated when a new edition of the manual is printed, the change dates are removed from the bottom of the pages and the new edition date is listed in Printing History and on the title page.

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General Information 1

Introduction

A service manual is supplied with the four channel test set you ordered along with the HP 54120B. To complete the service documentation for your system, unpack the four channel test set service manual and place it in the three ring binder supplied with the HP 54120B service manual.

This service manual contains information necessary to test, adjust and service the Hewlett-Packard 54120B Digitizing Oscilloscope Mainframe. This manual is divided into 9 sections as follows:

- 1 - General Information
- 2 - Installation
- 3 - Performance Tests
- 4 - Adjustments
- 5 - Replaceable Parts
- 6A - Disassembly
- 6B - Theory
- 6C - Service Menu Keys
- 6D - Troubleshooting

Information on operating, programming, and interfacing the HP 54120B is contained in the front panel operation reference supplied with each instrument.

The "General Information" section includes a description of the HP 54120B Digitizing Oscilloscope Mainframe, general characteristics, safety considerations, instruments covered by this manual, options, accessories supplied, recommended test equipment, and X-ray license forms. Specifications and operating characteristics are listed with the service manual for the four channel test set.

Also listed on the title page of this manual is a microfiche part number. This number can be used to order 4 x 6 inch microfilm transparencies of this manual. Each microfiche contains up to 96 photo-duplicates of manual pages. The microfiche package also includes the latest Manual Changes supplement as well as pertinent Service Notes.

Description

The HP 54120B is a fully programmable digitizing oscilloscope mainframe with a nine inch color display. The mainframe is capable of automated measurements and digital storage.

The color display provides several colors which are mapped to provide specific colors for specific display functions. For example, channel 1 is displayed in yellow, channel 2 in green, and error messages are displayed in red.

The HP 54120B contains extensive self-tests to ensure proper functioning of the oscilloscope. These self-tests are in addition to internal diagnostics that help locate faults efficiently and identify repairs, if a failure does occur.

Specifications & Operating Characteristics

All specifications and instrument operating characteristics are listed with the service manual for the four channel test set.

General Characteristics

The following general characteristics are not specifications, but typical characteristics included as additional information only.

Environmental Conditions

Temperature Operating: +15° C to +35° C (+59° F to +95° F).

Temperature Non-operating: -40° C to +70° C (-40° F to +158° F).

Humidity Operating: Up to 90% relative humidity at +35° C (95° F).

Humidity Non-operating: Up to 95% relative humidity at +65° C (+149° F).

Altitude Operating: Up to 4600 metres (15,000 ft).

Altitude Non-operating: Up to 15,300 metres (50,000 ft).

Vibration Operating: Random vibrations 5-500 Hz, 10 minutes per axis, ~0.3 g (rms).

Vibration Non-operating: Random vibration 5-500 Hz, 10 minutes per axis, =2.41 g (rms); and swept sine resonant search, 5-500 Hz, 0.75 g (0-peak), 5 minute resonant dwell at 4 resonances per axis.

Power Requirements

Power requirements listed are for the HP 54120B combined with a four channel test set. The four channel test set obtains its power over the provided interface cable from the HP 54120B.
Voltage: 115/230 Vac, -25% to + 15%, 48-66 Hz.
Power: 200 watts, 400 VA maximum.

Weight

HP 54120B Net: Approximately 20.5 kg (45 lb).

Dimensions

Dimensions are for general information only. If dimensions are required for building a special enclosure, contact your local Hewlett-Packard sales office. Dimensions are in millimetres and (inches). Refer to figure 1-1.

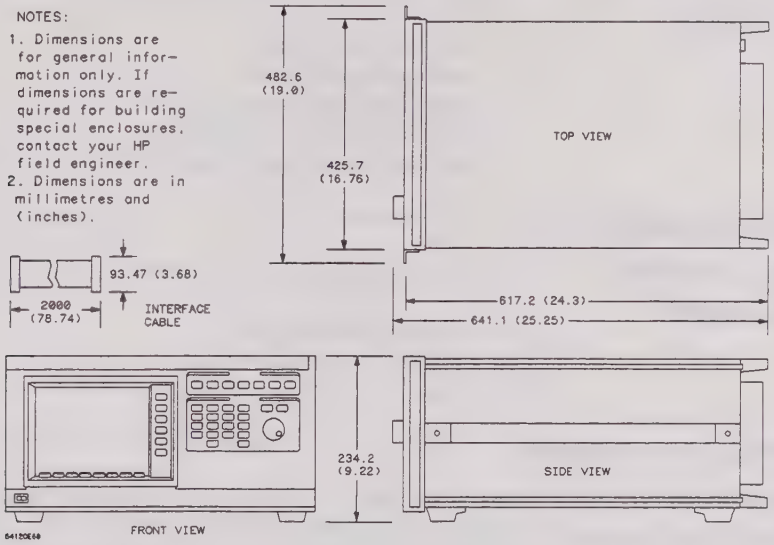

Figure 1-1. HP 54120B Dimensions

Safety Considerations

The appropriate sections contain safety information relevant to the service procedure it describes. Both the HP 54120B and this manual should be reviewed for safety markings and instructions before work is begun. Refer to the pages following the title page for safety summary and safety considerations.

Instruments Covered By This Manual

The HP 54120B's serial number is on the rear panel. Hewlett-Packard uses a two-part serial number consisting of a four-digit prefix and a five-digit suffix separated by a letter (0000A00000). The prefix is the same for all identical oscilloscopes and changes only when a modification is made that affects parts compatibility. The suffix differs for each oscilloscope. This manual applies directly to instruments with the serial prefix shown on the title page.

Options

The following options are available for the HP 54120B:

- Option 908 - Rack mount kit
- Option 910 - Additional copies of front panel operation reference
- Power cord options (see table 2-1)

Accessories Supplied

The following accessories are supplied with the HP 54120B.

- This Service Manual
- Getting Started Guide
- Front Panel Operation Reference
- Programming Reference Manual
- Antistatic mat with wrist strap (HP Part Number 9300-1346)

Accessories Available

The following accessories are available for the HP 54120B:

- Accessory kit HP 54007A
- 6 GHz Probe kit HP 54006A
- 22 ns Delay Line HP 54008A

Recommended Test Equipment

The test equipment recommended for maintaining the HP 54120B is listed in table 1-1. Any equipment which satisfies the critical specificatioins may be used. Section 4, Adjustments, is the only section which requires test equipment.

Table 1-1. Recommended Test Equipment

Instrument	Critical Specifications	Model
DMM	Better than 0.3% accuracy	HP 3478
Clip lead	Aligator to alligator	N/A

Systemizing

At the factory the HP 54120B Digitizing Oscilloscope Mainframe and the four channel test set are calibrated together as a system. This system will meet all published specifications when shipped from the factory. If the system is split up, (a different four channel test set is used with the HP 54120B) refer to the four channel test set service manual, "General Information" section, systemizing paragraph for your instrument.

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Installation 2

Introduction

This section contains installation instructions, information about operating environments, cleaning the HP 54120B, storage, and shipment.

Preparation For Use

Caution

To prevent damage to the instrument, make sure the line voltage selector switch is in the correct setting for your AC voltage source.

Power Requirements

The HP 54120B requires a power source of 115 or 230 Vac +15/-25 percent; 48 to 66 Hz single phase. Power consumption is 200 watts or 400 VA maximum.

Line Voltage Selection

A blade-type screwdriver may be used to change the position of the line select switch on the read panel to the correct voltage selection. Correctly setting the line switch sets the correct circuit breaker trip current. For 100 volt line operation, the line switch must be in the 115 V position.

Power Cables

This instrument is equipped with a three-wire power cable. When connected to an appropriate AC power outlet, this cable grounds the instrument cabinet. The type of power cable plug shipped with the instrument depends on the country of destination. See Table 2-1 for option numbers of available power cables and plug configurations.

Warning

To protect operating personnel from possible injury or death, the chassis must be properly grounded. The proper power cord must be used and the power cord ground must NOT be defeated. Refer to table 2-1 for power cable description and application.

Operating Environment

The operating environment is noted in the General Information section under General Characteristics. Note the non-condensing humidity limitation. Avoid condensation within the instrument because it can cause poor operation or malfunction.

Test Set Connection

Always insure a four channel test set is connected to the HP 54120B before applying power to the HP 54120B.

The HP 54120B Digitizing Oscilloscope Mainframe is connected to a four channel test set by the umbilical cable, HP Part Number 54120-61618. Connect the umbilical cable to the interface cable ports on the mainframe and four channel test set. Refer to figure 2-1. The mainframe supplies all power for the four channel test set over the umbilical cable.

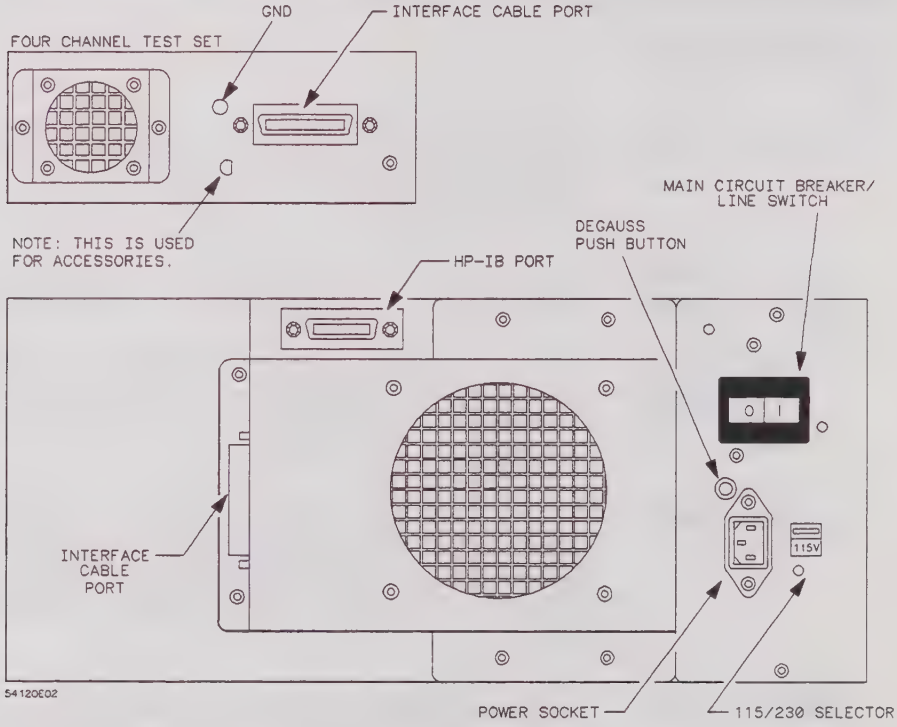


Figure 2-1. Rear Panel of Mainframe and Test Set

Cleaning

When cleaning the HP 54120B, CAUTION must be exercised about which cleaning agents are used. USE MILD SOAP AND WATER. If a harsh soap or solvent is used, the water-base paint finish WILL BE DAMAGED.

Caution

BE CAREFUL when cleaning the keyboard. Water can damage the keyboard circuit if it seeps under the keys.

Storage And Shipment

The instrument may be stored or shipped in environments with the following limits:

Temperature: -40° C to +70° C (-40° F to +158° F)
Humidity: Up to 95% at +65° C (+149° F)
Altitude: Up to 15,300 metres (50,000 feet)

Tagging For Service

The instrument should also be protected from temperature extremes which cause condensation within the instrument. Condensation within the instrument may cause a malfunction.

If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of servicing required, return address, model number, and full serial number. In any correspondence refer to the instrument by model number and full serial number.

Packaging

Original packaging i.e., containers and material identical to those used in factory packaging are available from Hewlett-Packard. If other packaging is to be used the following general instructions for repackaging with commercially available materials should be followed:

a. Wrap the oscilloscope in heavy paper or plastic.

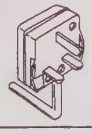
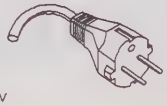
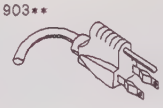
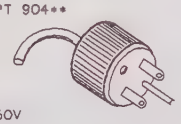
b. Use a strong shipping container. A double wall carton made of 2.4 MPa (350 psi) test material is adequate.

c. Use a layer of shock absorbing material 75 to 100 mm (3 to 4 inches) thick around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to ensure careful handling.

Table 2-1. Power Cord Configurations

PLUG TYPE	CABLE PART NO.	PLUG DESCRIPTION	LENGTH IN/CM	COLOR	COUNTRY
OPT 900  250V	8120-1351 8120-1703	Straight *BS1363A 90°	90/228 90/228	Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Zimbabwe, Singapore
OPT 901 250V	8120-1369 8120-0696	Straight *NZSS198/ASC 90°	79/200 87/221	Gray Mint Gray	Australia New Zealand
OPT 902  250V	8120-1689 8120-1692 8120-2857	Straight *CEE7-Y11 90° Straight (Shielded)	79/200 79/200 79/200	Mint Gray Mint Gray Coco Brown	East and West Europe, Saudi Arabia, So. Africa, India (Unpolarized in many nations)
OPT 903**  125V	8120-1378 8120-1521 8120-1992	Straight *NEMA5-15P 90° Straight (Medical) UL544	90/228 90/228 96/244	Jade Gray Jade Gray Black	United States, Canada, Mexico, Phillipines, Taiwan
OPT 904**  250V	8120-0698	Straight *NEMA6-15P	90/228	Black	United States, Canada
OPT 905 250V	8120-1396 8120-1625	CEE22-V1 (System Cabinet Use) 250V	30/76 96/244	Jade Gray	For interconnecting system components and peripherals. United States and Canada only
OPT 906 250V	8120-2104 8120-2296	Straight *SEV1011 1959-24507 Type 12 90°	79/200 79/200	Mint Gray Mint Gray	Switzerland
OPT 912 220V	8120-2956 8120-2957	Straight *DHCK107 90°	79/200 79/200	Mint Gray Mint Gray	Denmark
OPT 917 250V	8120-4211 8120-4600	Straight SABS164 90°	79/200 79/200	Jade Gray	Republic of South Africa India
OPT 918 100V	8120-4753 8120-4754	Straight Miti 90°	90/230 90/230	Dark Gray	Japan

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*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP part number for complete cable including plug.

**These cords are included in the CSA certification approval of the equipment.

E=Earth Ground
L=Line
N=Neutral

Performance Tests 3

Introduction

This section normally contains the performance verification tests. Since there are no specifications for the mainframe to test, there are no performance tests for the mainframe. Refer to the four channel test set service manual for the performance tests.

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Adjustments

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Adjustments 4

Introduction

This section describes the adjustments for returning the instrument to peak operating capabilities after repairs have been made or during routine preventive maintenance.

Warning

Read the "Safety Summary" at the front of this manual before performing adjustment procedures. The instrument should be disconnected from all voltage sources before it is opened for any adjustments, replacements, maintenance, or repairs.

Adjustment Interval

Adjustments are needed if the test set fails to pass the performance verification test in the test set service manual. Some or all of these adjustments may need to be made after repairs have been completed. Amount of use, environmental conditions, and the user's experience concerning need for adjustment verification will contribute in deciding the adjustment interval. Also refer to the "Performance Test Interval" in the performance tests section of the test set service manual.

Recommended Test Equipment

Table 1-1 lists the recommended test equipment to use for the adjustment procedures. Any equipment that satisfies the critical specifications may be used.

Adjustment Sequence

This is the factory recommended sequence of adjustments.

Note

The mainframe adjustments must be performed before the test set adjustments are performed.

- Power Supply Adjustments
- Timebase Delta Current Adjustment
- +10.000 Reference Voltage Adjustment

Power Supply Adjustments

This procedure is for adjusting the power supply voltages in cases when either the power supplies have been inadvertently misadjusted or when repairs have been made.

Note The power supply voltages are factory set and rarely require readjustment.

Equipment

This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
DMM	Better than 0.3% accuracy	HP 3478A

Analog Supply

This adjustment was never installed on HP 54120B mainframes. If you have an older HP 54120A mainframe you need to check to see if your instrument contains A12R61 before continuing with this procedure. A12R61 was the only adjustment on the Analog Power Supply assembly. The test point locations are marked on the power supply cover and on the Analog PC assembly (A12). This procedure adjusts the fan supply voltage.

Note The instrument must be stabilized at ambient temperature with front-panel power switch to STBY before this adjustment is made. The fan voltage will increase with the instrument's internal temperature. If the instrument is not allowed to cool down, the following voltage measurement and adjustment will be inaccurate.

1. Remove two top rear feet from mainframe.
2. Remove top cover from mainframe.
3. Connect positive voltmeter lead to FAN test point.
4. Connect negative voltmeter lead to -18 V test point.
5. Turn instrument on.
6. Before the instrument warms up, adjust A12R61 for a voltmeter reading of 9.5 V ± 100 mV.

Digital Supply

The test point locations are marked on the power supply cover and on the Digital PC assembly (A13). A13R56 is the only adjustment on the Digital Power Supply assembly. First, the voltage is measured to see if any adjustment is required.

1. Turn instrument on and allow it to warm up for approximately two minutes.
2. Connect positive voltmeter lead to +5 V test point (actual voltage = +5.1 V).
3. Connect negative voltmeter lead to -5 V test point (actual voltage = -5.3 V).
4. The voltmeter should read +10.4 Vdc ±10 mV. If the measurement is within specifications, stop here. If the measurement is out of specifications, then continue with steps 5 through11.
5. Disconnect power cord from rear of instrument and remove voltmeter leads.

Warning

Hazardous voltages capable of causing injury or death are present on the AC Power Supply assembly (A11) when power is applied and for a period of time after power is removed from the instrument. To avoid this hazard, DO NOT remove the power supply shield until the LED on the AC Power Supply assembly (A11) is extinguished. This LED is visible through an inspection hole in the cover labeled "+300 V WHEN LAMP IS ON".

6. When the +300 V lamp is extinguished, remove the top power supply cover.
7. Reconnect positive voltmeter lead to +5 V test point.
8. Reconnect negative voltmeter lead to -5 V test point.
9. Reconnect power cord and turn instrument on. Allow instrument to warm up for approximately two minutes.
10. Adjust A13R56 for a voltmeter reading of +10.4 Vdc ±10 mV.
11. Disconnect power cord and wait until +300 V lamp is extinguished.
12. Disconnect voltmeter leads before reinstalling power supply cover.

Timebase Delta Current Adjustment

This is a timebase system adjustment. After this adjustment is made, any four channel test set may be used with this mainframe without degrading the timebase accuracy specifications. A3R29, on the Horizontal Control board, is adjusted for proper delta (change) in output current flow from the fine delay DAC on the Horizontal Control board to the four channel test set is, when delay is switched from 16.000 ns to 19.999 ns.

The procedure consists of three main parts.

1. Steps 1 through 6 measure the resistance of A3R46. This is the resistance value in the ohm's law formula $I = E \div R$ used in step 12.

2. Steps 6 through 12 measure the voltage across A3R46 with the oscilloscope's timebase delay set to 16.000 ns. This is the voltage value in the ohm's law formula $I = E \div R$ used in step 12.

3. Steps 13 through 21 calculate the desired delta current across A3R46 when the oscilloscope's timebase delay is changed from 16.000 ns to 19.999 ns. A3R29 is adjusted if the measured delta current does not equal the desired delta current.

Equipment

This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
DMM	40 μV and 24 milliohm accuracy	HP 3478A
Clip lead	Alligator to alligator	N/A

Procedure

Part 1: Determining R in the ohm's law formula I = E ÷ R

1. Turn mainframe's front-panel power switch to STBY.

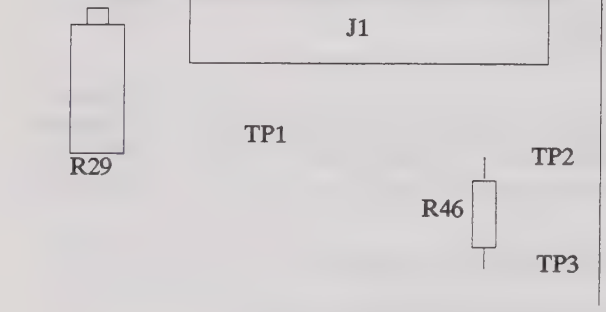
2. Place DMM in four-wire resistance measurement mode.

3. Connect one end of alligator clip lead to (A3) TP2.

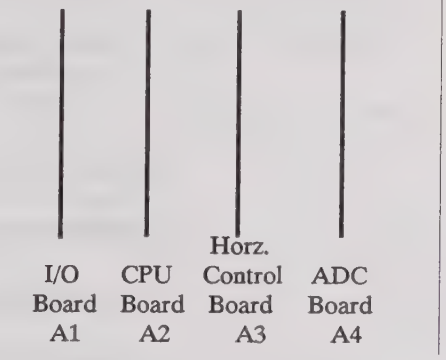
4. Connect both positive DMM leads to other end of alligator clip lead.

5. Connect both negative DMM leads to ground point TP3.

Top-Rear Corner of Horizontal Control Assembly (A3)



Top View of Mainframe's Card Cage



Front of Card Cage Assembly

6. Record resistance reading in steps 12 and 14 (2 places after the decimal are required).
   Example: 200.06 Ω. Leave DMM connected across A3R46.

Part 2: Determining E in the ohm's law formula I = E ÷ R

7. Disconnect the ribbon cables which attach to the rear of the horizontal control and ADC assemblies.

8. Change DMM to make voltage measurements.

9. Short Horizontal Control assembly (A3) test point TP1 to TP2.

10. Turn mainframe power on, and set timebase delay to 16 ns.

11. Record DMM voltage reading in step 12 (5 places after the decimal are required).
    Example: -1.00039 V.

	Example
12. Record DMM voltage reading from step 11 here_____ V	-1.00039 V
Record DMM resistance reading from step 6 here _____ Ω	200.06 Ω
Divide voltage by resistance to obtain current _____ mA (four digits after the decimal are required, and drop the negative sign).	5.0004 mA

The result of the calculation is the fine delay DAC output current at delay value of 16.000 ns. Record this value in step 13.

Part 3: Steps 13 through 21 calculate the value to which A3R29 should be set.

13. Subtract the current result in step 12 from desired delta current 9.7632 mA. 9.7632 mA - (_____ mA) = _____ mA. Record this value in step 14.

    Example: 9.7632 mA - 5.0004 mA = 4.7628 mA

14. Convert calculated current from step 13 to a voltage value by multiplying it by the resistance value in step 6.

	Example
Record calculated current from step 13 here _____ mA	4.7628 mA
Record DMM resistance reading from step 6 here _____ Ω	200.06 Ω
Multiply resistance by current to obtain a voltage _____ V	0.95284576 V

15. Round voltage value from step 14 to 5 decimal places _____V 0.95285 V

16. Change mainframe's timebase delay setting to 19.999 ns.

17. With DMM still connected across TP2 and TP3, check DMM voltage reading. If voltmeter reading is equal to calculated voltage in step 15, then go to step 18. Otherwise, adjust A3R29 for a DMM voltage reading as close as possible to the calculated value in step 15.

18. Turn mainframe's front-panel power switch to STBY.

19. Remove short from TP1 to TP2.

20. Disconnect DMM from mainframe.

21. Reconnect ribbon cable disconnected in step 7.

+10 Volt Reference Adjustment

This is a systemizing adjustment which allows any test set to be used with this mainframe without degrading the vertical gain specifications.

Equipment

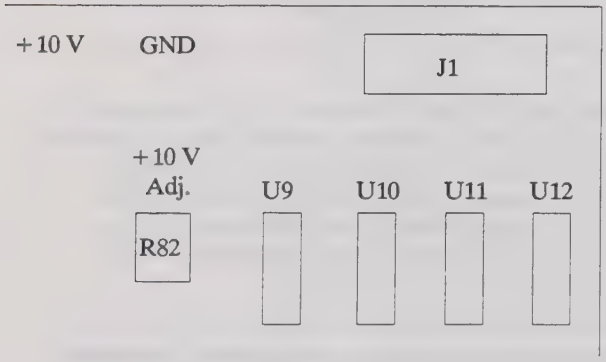
This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
DMM	0.01% accuracy	HP 3478A

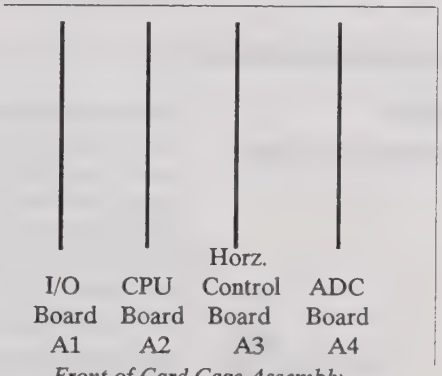
Procedure

1. Turn mainframe's front-panel power switch to STBY.
2. Connect positive DMM lead to +10 V test point on ADC assembly (A4).
3. Connect negative DMM lead to ground test point next to +10 V test point.
4. Turn mainframe's front-panel power switch to ON.
5. Adjust +10 V ADJUST (R82) for +10 V ±1 mV.
6. Disconnect DMM leads from ADC assembly.
7. Reinstall mainframe's top cover and two top rear feet.

Top-Rear Corner of ADC Assembly (A4)



Top View of Mainframe's Card Cage



Front of Card Cage Assembly

CRT Color Module Introduction

The CRT color module requires no adjusting when used in a normal environment. The procedure given here is for CRT color convergence. Do not perform these adjustments as part of regular maintenance. Observe the following rules before making the adjustments:

- Do not perform this procedure as normal maintenance.
- Make adjustments only if the instrument has been subjected to extreme magnetic environments and the colors are incorrect.
- Before making any adjustments, try degaussing the unit using the rear panel degaussing switch or a color television type degaussing coil (refer to Degaussing the Display procedure, this section).
- Only qualified personnel who are familiar with color CRT convergence procedures should perform this adjustment.
- Before adjustments are made, mark the position where potentiometers are. This allows you to return the adjustments to their original starting position.

Degaussing the Display

After the instrument has been used for a while, the CRT may become magnetized and color or other data may become distorted. To correct, press the **Degauss** button on the rear panel several times.

If the instrument has been subjected to strong magnetic fields, it may be necessary to degauss the CRT with a conventional television type degaussing coil.

Safety Considerations

Although this instrument has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation, service, and repair of the instrument. Failure to comply with the precautions listed in the Safety Summary at the front of this manual, or with specific warnings given throughout this manual, could result in serious injury or death. Service adjustments should be performed only by qualified service personnel.

Warning

Read the Safety Summary at the front of this manual before performing adjustment procedures. The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance, or repair.

CRT Color Module Adjustments

The CRT Color Module is adjusted to compensate for external magnetic influences causing misconvergence.

Note

DO NOT PERFORM THESE ADJUSTMENTS DURING ROUTINE CALIBRATION. The earth's magnetic field or the user's environment may cause an unstable display which cannot be corrected by degaussing the screen. The following procedures are provided for those few extreme cases.

Note

DO NOT continue with this procedure before first degaussing the CRT screen with the rear panel degaussing switch. In extreme cases of magnetism, it may be necessary to degauss the CRT with a conventional external television-type degaussing coil. During any of the following adjustments, the CRT module must face west.

Equipment

This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

Accessory	Critical Specifications	HP Part Number
N/A	Alignment tool non-metallic	8710-1355

Note

The following adjustments are broken down into groups. Follow their sequence because they interact and depend on each other. Figure 4-1 is a drawing of the adjustment sequence. In some cases not all the adjustment groups are used. For example, if the Geometry Adjustment Group corrects the problem, this will be the only group used.

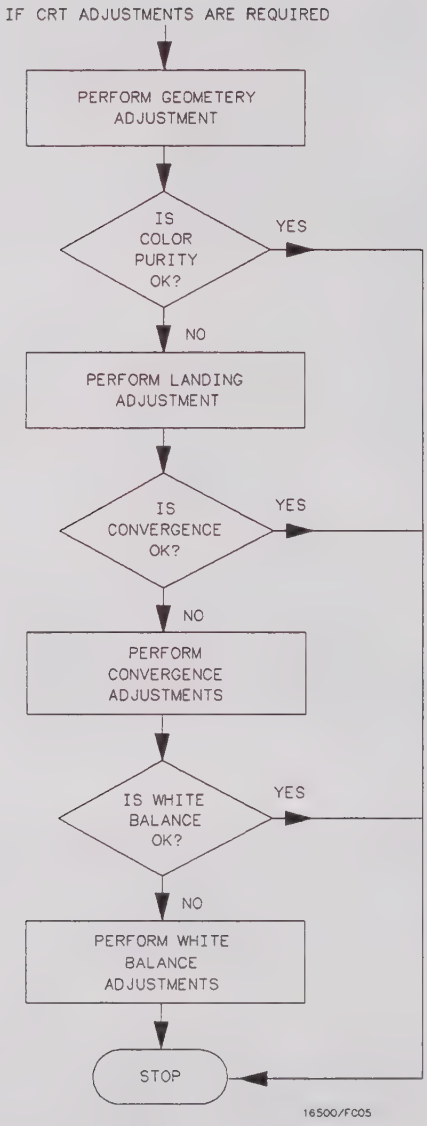


Figure 4-1. CRT Adjustment Sequence

Geometry Adjustments

1. Press **Utility** menu key and **CRT SETUP** key.
   Press **CRT PATTERN** key until a white cross hatch is displayed on CRT.

2. Preset front-panel BACKGROUND control to mechanical center.

3. Preset front-panel CONTRAST control maximum clockwise.

4. Preset H.SUB SHIFT (RV006) and V.SUB SHIFT (RV008) on bottom PC board to mechanical center.

5. With a flexible ruler, adjust H.SIZE (RV504) and V.HEIGHT (RV502) on left hand side PC board so cross-hatch pattern's border displayed on CRT is 120.5 mm (4.74 in.) vertically and 161 mm (6.34 in.) horizontally.

6. Adjust V.CENT (RV510) and H.CENT (RV503) on left hand side PC board to center pattern.

7. Adjust PIN AMP (RV506) on left hand side PC board to eliminate pincushion distortion in the vertical lines of the cross-hatch pattern. Refer to figure 4-2.

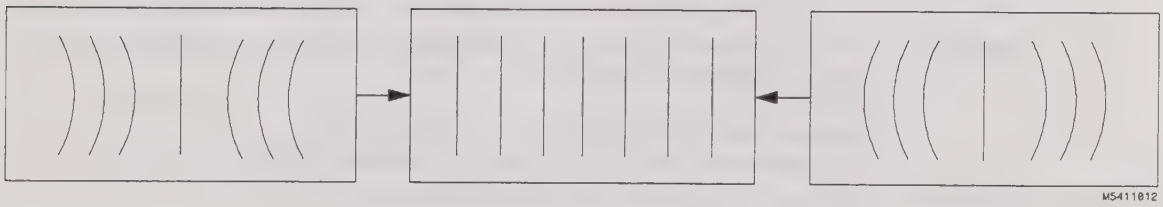


Figure 4-2. PIN AMP Adjustment

8. Adjust PIN PHASE (RV505) on left side PC board to eliminate pin phase distortion in vertical lines of cross-hatch pattern. Refer to figure 4-3.

9. Adjust TOP PIN (RV511) on left hand side PC board until the horizontal line is parallel with center horizontal line.

10. Adjust BOTTOM PIN (RV512) on left hand side PC board until the bottom horizontal line is parallel with center horizontal line.

Figure 4-3. PIN PHASE Adjustment

Landing, Convergence, and Focus Adjustment Preparation:

1. Remove CRT Display Module from instrument. See disassembly section 6A-9.

2. Reconnect instrument front panel, install front panel and CRT bezel (using two screws to temporarily hold front panel in place).

Steps 3-5 are performed only when the CRT has been replaced.

3. Loosen deflection yoke clamp screw.

4. With CRT Display Module placed to mainframe's left, reconnect module.

Note Note the original routing of the module power cable for proper routing when module is installed in instrument. Then, route the module power cable from inside the module to the outside (left side) of module for reconnection to the power supplies.

---

5. Remove deflection yoke spacers by moving deflection yoke rearward and removing spacers.

Note The deflection yoke spacers are tapered rubber blocks between front of yoke and rear of CRT funnel.

---

6. Apply power and allow instrument to thermally stabilize for 20 minutes.

Focus Adjustment

Note Perform the geometry adjustments before making focus adjustment.

---

1. Press **Utility** menu key and **CRT SETUP** key.
   Press **CRT PATTERN** key until a white cross-hatch is displayed on CRT.

2. Adjust FOCUS (RV701) on rear PC board for best overall focus.

Landing Adjustment

1. Press **Utility** menu key and **CRT SETUP** key.
   Press **COLOR PURITY** key until a white raster is displayed on CRT.

2. Turn front panel CONTRAST control fully clockwise.

3. Degauss entire CRT screen by pressing DEGAUSSING switch on instrument's rear panel.

Note

In cases where the user's environment or shipping environment has caused high levels of magnetization to take place, it may be necessary to externally degauss the CRT with a conventional television-type degaussing coil to completely degauss the CRT.

4. Set purity magnet tabs to mechanical center. Refer to figure 4-4.

5. Press **COLOR PURITY** key until a green raster is displayed on CRT.

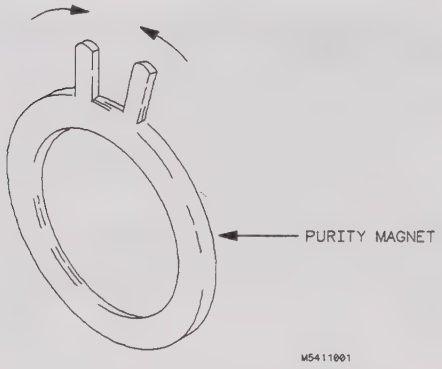


Figure 4-4. Purity Magnet Centering

Step 6 is performed only if the CRT has been replaced.

6. Move deflection yoke rearward until left edge of raster turns red and right side of raster turns blue. Refer to figure 4-5.

7. Adjust purity magnets until green is in center of raster with red and blue bands evenly distributed on sides. Refer to figure 4-5.

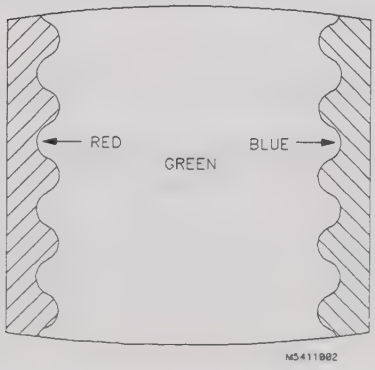


Figure 4-5. Purity Magnet Adjustment Raster

Step 8 is performed only if CRT has been replaced.

8. Move deflection yoke forward until entire raster is green.

Note Landing adjustment is easier if yoke is moved all the way forward, then moved rearward until raster is completely green.

---

9. With COLOR PURITY key, replace green raster with red, then with blue raster. Check each raster for proper landing adjustment or color purity.

10. If landing is not correct in step 9, repeat steps 6 through 9 for best compromise. Refer to figure 4-6.

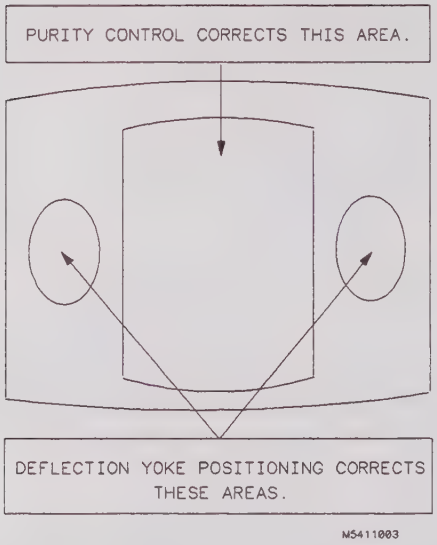


Figure 4-6. Landing and Purity Adjustment Guide

11. If landing is not correct in step 10, readjust purity magnets for best landing of each color.

Step 12 is performed only if the CRT has been replaced.

12. When landing adjustment is complete, tighten deflection yoke clamp screw just enough to keep yoke from moving. **DO NOT** over tighten.

Note While moving deflection yoke forward and rearward, rotate yoke as necessary to make vertical edges of raster parallel to the sides of the instrument frame.

Static Convergence

1. Preset front-panel BACKGROUND control to mechanical center.

2. Preset front-panel CONTRAST control maximum clockwise.

3. Temporarily disconnect power from instrument and remove PC board shield cover from rear of CRT Display Module by prying evenly on all four sides.

4. Apply power and press Utility menu key and CRT SETUP key. Press **CRT PATTERN** key until a white cross-hatch pattern is displayed.

5. Check four dots which are around center intersection of cross-hatch pattern for coincidence of blue, red, and green dots. If the dots are not coincident, adjust H.STAT (RV703) on rear PC board to obtain horizontal coincidence and V.STAT (RV803) on bottom PC board to obtain vertical coincidence. Refer to figure 4-7.

Note

Due to interaction, BEAM LANDING will need to be re-adjusted if either H.STAT or V.STAT adjustments are made. Once BEAM LANDING is readjusted, repeat step 5 above if necessary to obtain center screen coincidence of the dots.

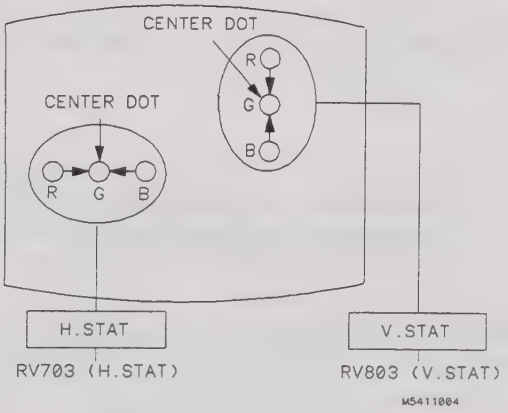


Figure 4-7. Static Convergence

Dynamic Convergence

1. Press **Utility** menu key and CRT **SETUP** key.
   Press **CRT PATTERN** key until a white cross-hatch pattern is on CRT.

2. Adjust Y BOW (RV805) on bottom PC board to eliminate red, green, and blue bowing at top and bottom of center vertical line. Refer to figure 4-8.

3. Adjust Y BOW CROSS (RV804) on bottom PC board to eliminate red, green, and blue orthogonal misalignment at top and bottom of center vertical line. Refer to figure 4-9.

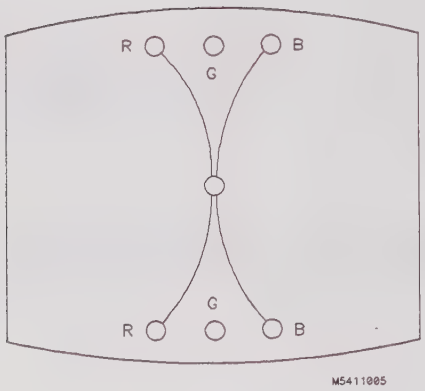


Figure 4-8. Y BOW Adjustment

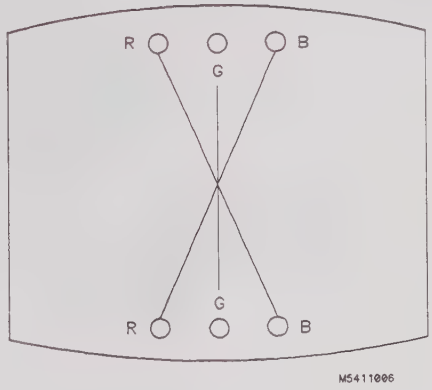


Figure 4-9. Y BOW CROSS Adjustment

4. Adjust V.STAT TOP (RV801) and V.STAT BOTTOM (RV802) on bottom PC board to obtain coincidence of red, blue, and green at intersection of top and bottom horizontal lines with center vertical line. Refer to figures 4-10 and 4-11.

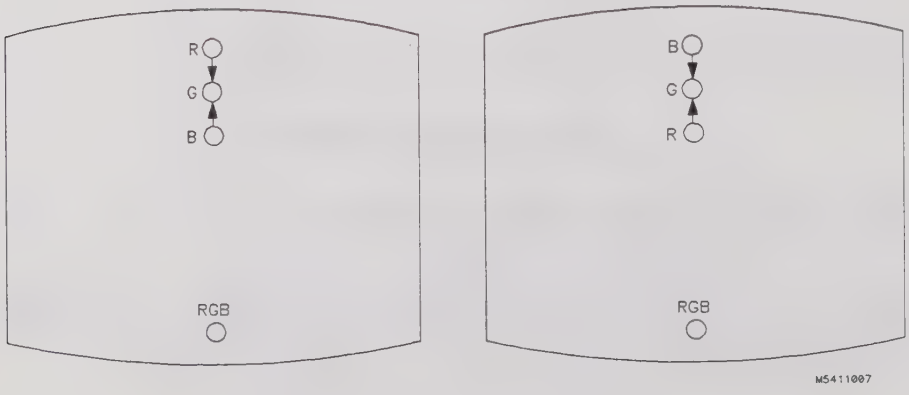


Figure 4-10. V.STAT TOP Adjustment

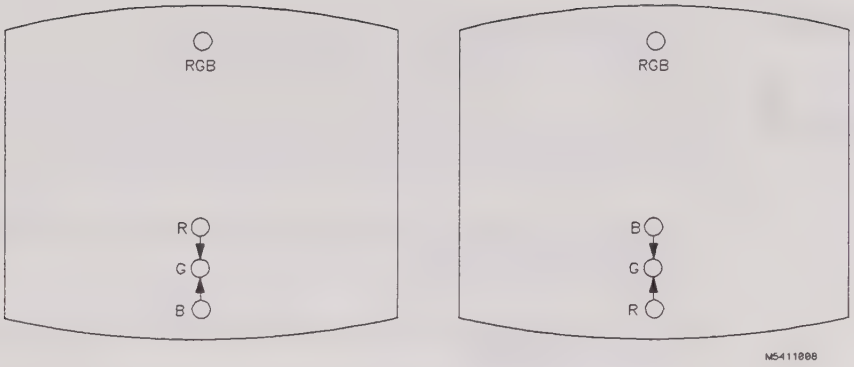


Figure 4-11. V.STAT BOTTOM Adjustment

5. Adjust H.AMP (RV807) on bottom PC board for equal amounts of misconvergence at right and left sides of screen. Refer to figure 4-12.

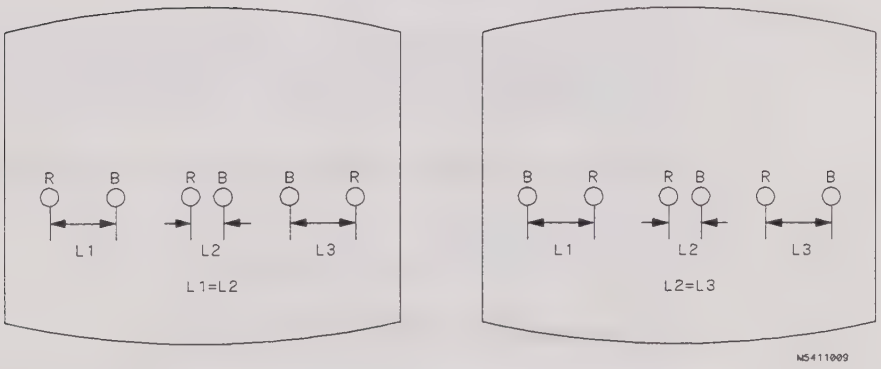


Figure 4-12. H.AMP Adjustment

6. Adjust H.TILT (RV806) on bottom PC board for coincidence of red, green, and blue at right and left sides of screen. Refer to figure 4-13.

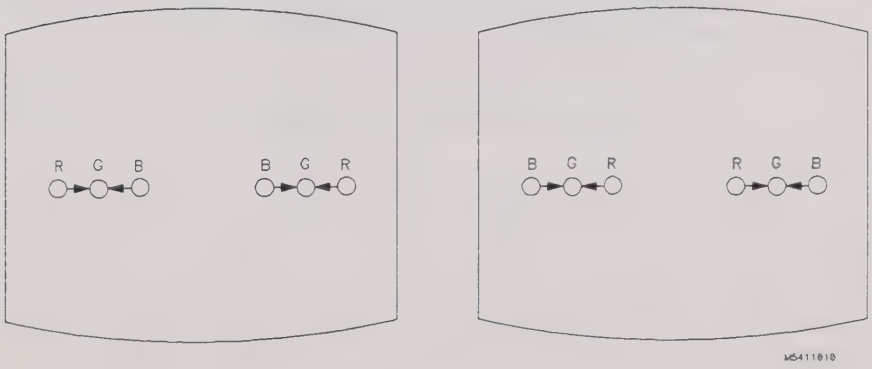


Figure 4-13. H.TILT Adjustment

White Balance

1. Press **Utility** menu key.
   Press **LIGHT OUTPUT** key until a blank raster is on CRT.

Note

The completely blank raster will contain a test for the function keys on the right side of the display. However, it will not affect this adjustment.

2. Set front-panel BACKGROUND and SUB BRT (RV901) on bottom PC board to mechanical center.

3. Set front-panel BRIGHTNESS and SUB CONT (RV902) on bottom PC board to mechanical center.

4. Set G. DRIVE (RV921), B. DRIVE (RV9310), and R. DRIVE (RV911) on bottom PC board to mechanical center.

5. Set G.BKG (RV721), B.BKG (RV731), and R.BKG (RV711) on rear PC board fully counterclockwise (CCW).

6. Adjust SCREEN (RV702) on rear PC board until either a red, green, or blue raster just starts to become visible. Note which color becomes visible first and do not adjust background control (BKG) for that color in the step 7.

7. Adjust other two background (BKG) controls for best white balance.

8. Press **Utility** menu key.
   Press **COLOR PURITY** key until a white raster is on CRT.

9. Set front panel BRIGHTNESS control at maximum.

10. Observe screen and adjust DRIVE controls (RV921, RV931, and RV911) on bottom PC board for best white balance.

Note

White balance is checked in two ways. First, with an average piece of white photocopy paper, compare the white on the CRT to the paper. Second, in the CONFIDENCE TEST function, the gray scale blocks are checked to make sure the block at the far left of the CRT is visible.

11. Repeat steps 1 through 3 and 6 through 10 for best overall white balance.

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Replaceable Parts 5

Introduction

This section contains information for ordering parts. Table 5-1 lists the names and addresses that correspond to the manufacturers' code numbers. Table 5-2 lists the abbreviations used in the parts list and throughout this manual. Figures 5-1 through 5-6 are drawings with reference designators included. Table 5-3 is the replaceable parts list.

Abbreviations

Table 5-2 lists the abbreviations used in the replaceable parts list. Abbreviations in the replaceable parts list are always in capital letters. In other sections of this manual abbreviations may be in capital or lower case letters.

Replaceable Parts List

Table 5-3 is a list of replaceable parts and is organized as follows:

a. Electrical assemblies in alphanumerical order by reference designation.

b. Chassis mounted parts in alphanumerical order by reference designation.

Information given for each part consists of the following:

a. Hewlett-Packard part number and the check digit (for HP internal use).

b. Total quantity (Qty) in the instrument, given only once at the part number's first appearance in the list.

c. Description of part.

d. A typical manufacturer of a given part in a five digit code. Refer to table 5-1 for a cross reference from code number to manufacturer name.

e. The manufacturers' part number.

Exchange Assemblies

Some of the assemblies used in this instrument have been set up on the exchange program. This allows the customer to exchange his faulty assembly with one that has been repaired, adjusted, and performance verified by the factory. The cost is significantly less than that of a new assembly.

Exchange assemblies are listed at the beginning of the replaceable parts table with a star (*) before the reference designator. They have a part number in the form XXXXX-695XX.

Before ordering an exchange assembly, check with your local parts or repair organization for the procedures associated with the exchange assembly program.

Ordering Information

To order a part listed in the replaceable parts table, indicate the Hewlett-Packard part number, check digit, and quantity required. Send the order to the nearest Hewlett-Packard office.

To order a part that is not listed in the replaceable parts table, include the instrument model number, serial number, description and function of part, and total quantity required. Address an order to the nearest Hewlett-Packard sales office.

Direct Mail Order System

Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using this system are as follows:

a. Direct ordering and shipment from HP Parts Center in Mountain View, California. Call your local Hewlett-Packard office for the toll free number

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through local HP offices when orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices. To provide these advantages, check or money order must accompany each order. Mail order forms and specific ordering information are available through your local Hewlett-Packard offices.

Table 5-1. List of Manufacturers' Codes

Mfr No.	Manufacturer Name	Address		Zip Code
04713	Motorola Semi Conductor Products	Phoenix	Az	85008
06915	Pan Asian Paper Product Mfg SDN BHD	Pinang		Malaysia
28480	Hewlett-Packard Co. Corporate HQ	Palo Alto	Ca	94304
86928	Seastrom Mfg Co.	Glendale	Ca	91201

Table 5-2. Reference Designator and Abbreviations

REFERENCE DESIGNATOR

A	= assembly	F	= fuse	Q	= transistor;SCR; triode thyristor	U	= integrated circuit; microcircuit
B	= fan;motor	FL	= filter			V	= electron tube; glow lamp
BT	= battery	H	= hardware	R	= resistor		
C	= capacitor	J	= electrical connector (stationary portion);jack	RT	= thermistor	VR	= voltage regulator; breakdown diode
CR	= diode;diode thyristor; varactor	L	= coil;inductor	S	= switch;jumper	W	= cable
DL	= delay line	MP	= misc. mechanical part	T	= transformer	X	= socket
DS	= annunciator;lamp;LED	P	= electrical connector (moveable portion);plug	TB	= terminal board	Y	= crystal unit(piezo-electric or quartz)
E	= misc. electrical part			TP	= test point		

ABBREVIATIONS

A	= amperes	DWL	= dowel	MFR	= manufacturer	RND	= Round
A/D	= analog-to-digital	ECL	= emitter coupled logic	MICPROC	= microprocessor	ROM	= read-only memory
AC	= alternating current	ELAS	= elastomeric	MINTR	= miniature	RPG	= rotary pulse generator
ADJ	= adjust(ment)	EXT	= external	MISC	= miscellaneous	RX	= receiver
AL	= aluminum	F	= farads;metal film (resistor)	MLD	= molded	S	= Schottky-clamped; seconds(time)
AMPL	= amplifier			MM	= millimeter		
ANLG	= analog	FC	= carbon film/ composition	MO	= metal oxide	SCR	= screw;silicon controlled rectifier
ANSI	= American National Standards Institute	FD	= feed	MTG	= mounting	SEC	= second(time);secon dary
		FEM	= female	MTLC	= metallic		
ASSY	= assembly	FF	= flip-flop	MUX	= multiplexer	SEG	= segment
ASTIG	= astigmatism	FL	= flat	MW	= milliwatt	SEL	= selector
ASYNCHRO	= asynchronous	FM	= foam;from	N	= nano(10^{-9})	SGL	= single
ATTEN	= attenuator	FR	= front	NC	= no connection	SHF	= shift
AWG	= American wire gauge	FT	= gain bandwidth product	NMOS	= n-channel metal-oxide-semiconductor	SI	= silicon
BAL	= balance					SIP	= single in-line package
BCD	= binary-code decimal	FW	= full wave	NPN	= negative-positive-negative		
BD	= board	FXD	= fixed	NPRN	= neoprene	SKT	= skirt
BFR	= buffer	GEN	= generator	NRFR	= not recommended for field replacement	SL	= slide
BIN	= binary	GND	= ground(ed)			SLDR	= solder
BRDG	= bridge	GP	= general purpose	NSR	= not separately replaceable	SLT	= slot(ted)
BSHG	= bushing	GRAT	= graticule			SOLD	= solenoid
BW	= bandwidth	GRV	= groove	NUM	= numeric	SPCL	= special
C	= ceramic;cermet (resistor)	H	= henries;high	OBD	= order by description	SQ	= square
		HD	= hardware	OCTL	= octal	SREG	= shift register
CAL	= calibrate;calibration	HDND	= hardened	OD	= outside diameter	SRQ	= service request
CC	= carbon composition	HG	= mercury	OP AMP	= operational amplifier	STAT	= static
CCW	= counterclockwise	HGT	= height	OSC	= oscillator	STD	= standard
CER	= ceramic	HLCL	= helical	P	= plastic	SYNCHRO	= synchronous
CFM	= cubic feet/minute	HORIZ	= horizontal	P/O	= part of	TA	= tantalum
CH	= choke	HP	= Hewlett-Packard	PC	= printed circuit	TBAX	= tubeaxial
CHAM	= chamfered	HP-IB	= Hewlett-Packard Interface Bus	PCB	= printed circuit board	TC	= temperature coefficient
CHAN	= channel			PD	= power dissipation	TD	= time delay
CHAR	= character	HR	= hour(s)	PF	= picofarads (10^{-12})	THD	= thread(ed)
CM	= centimeter	HV	= high voltage	PI	= plug in	THK	= thick
CMOS	= complementary metal-oxide-semiconductor	HZ	= Hertz	PL	= plate(d)	THRU	= through
		I/O	= input/output	PLA	= programmable logic array	TP	= test point
CMR	= common mode rejec-tion	IC	= integrated circuit			TPG	= tapping
		ID	= inside diameter	PLST	= plastic	TPL	= triple
CNDCT	= conductor	IN	= inch	PNP	= positive-negative-positive	TRANS	= transformer
CNTR	= counter	INCL	= include(s)			TRIG	= trigger(ed)
CON	= connector	INCAND	= incandescent	POLYE	= polyester	TRMR	= trimmmer
CONT	= contact	INP	= input	POS	= positive;position	TRN	= turn(s)
CRT	= cathode-ray tube	INTEN	= intensity	POT	= potentiometer	TTL	= transistor-transistor
CW	= clockwise	INTL	= internal	POZI	= pozidrive	TX	= transmitter
D	= diameter	INV	= inverter	PP	= peak-to-peak	U	= micro(10^{-6})
D/A	= digital-to-analog	JFET	= junction field-effect transistor	PPM	= parts per million	UL	= Underwriters Laboratory
DAC	= digital-to-analog converter			PRCN	= precision		
		JKT	= jacket	PREAMP	= preamplifier	UNREG	= unregulated
DARL	= darlington	K	= kilo(10^{3})	PRGMBL	= programmable	VA	= voltampere
DAT	= data	L	= low	PRL	= parallel	VAC	= volt,ac
DBL	= double	LB	= pound	PROG	= programmable	VAR	= variable
DBM	= decibel referenced to 1mW	LCH	= latch	PSTN	= position	VCO	= voltage-controlled oscillator
		LCL	= local	PT	= point		
DC	= direct current	LED	= light-emitting diode	PW	= potted wirewound	VDC	= volt,dc
DCDR	= decoder			PWR	= power	VERT	= vertical
DEG	= degree	LG	= long	R-S	= reset-set	VF	= voltage,filtered
DEMUX	= demultiplexer	LI	= lithium	RAM	= random-access memory	VS	= versus
DET	= detector	LK	= lock			W	= watts
DIA	= diameter	LKWR	= lockwasher	RECT	= rectifier	W/	= with
DIP	= dual in-line package	LS	= low power Schottky	RET	= retainer	W/O	= without
DIV	= division	LV	= low voltage	RF	= radio frequency	WW	= wirewound
DMA	= direct memory access	M	= mega(10^{6});megohms; meter(distance)	RGLTR	= regulator	XSTR	= transistor
DPDT	= double-pole, double-throw			RGTR	= register	ZNR	= zener
		MACH	= machine	RK	= rack	°C	= degree Celsius (Centigrade)
DRC	= DAC refresh controller	MAX	= maximum	RMS	= root-mean-square		
DRVR	= driver					°F	= degree Fahrenheit
						°K	= degree Kelvin

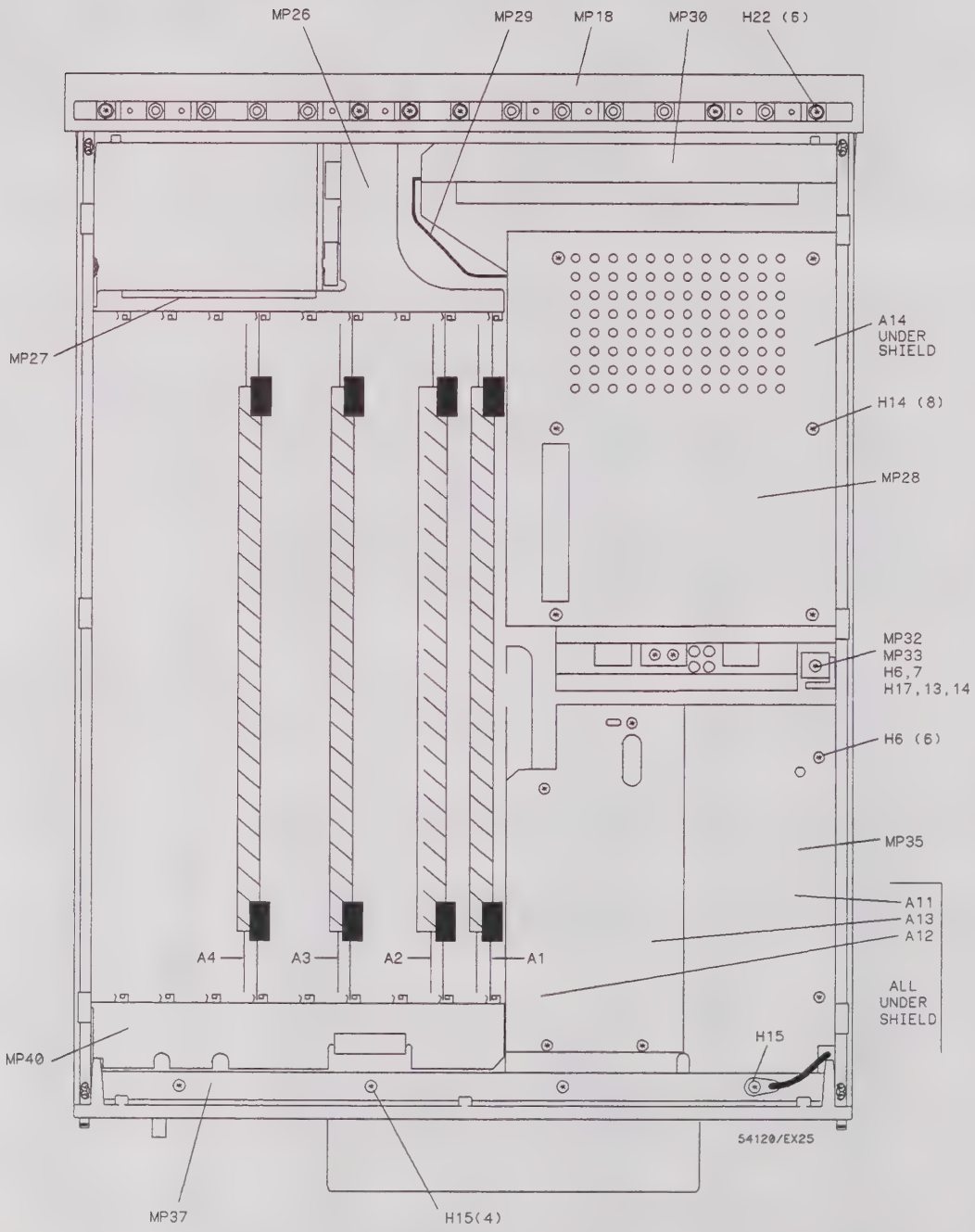

Figure 5-1. Top View

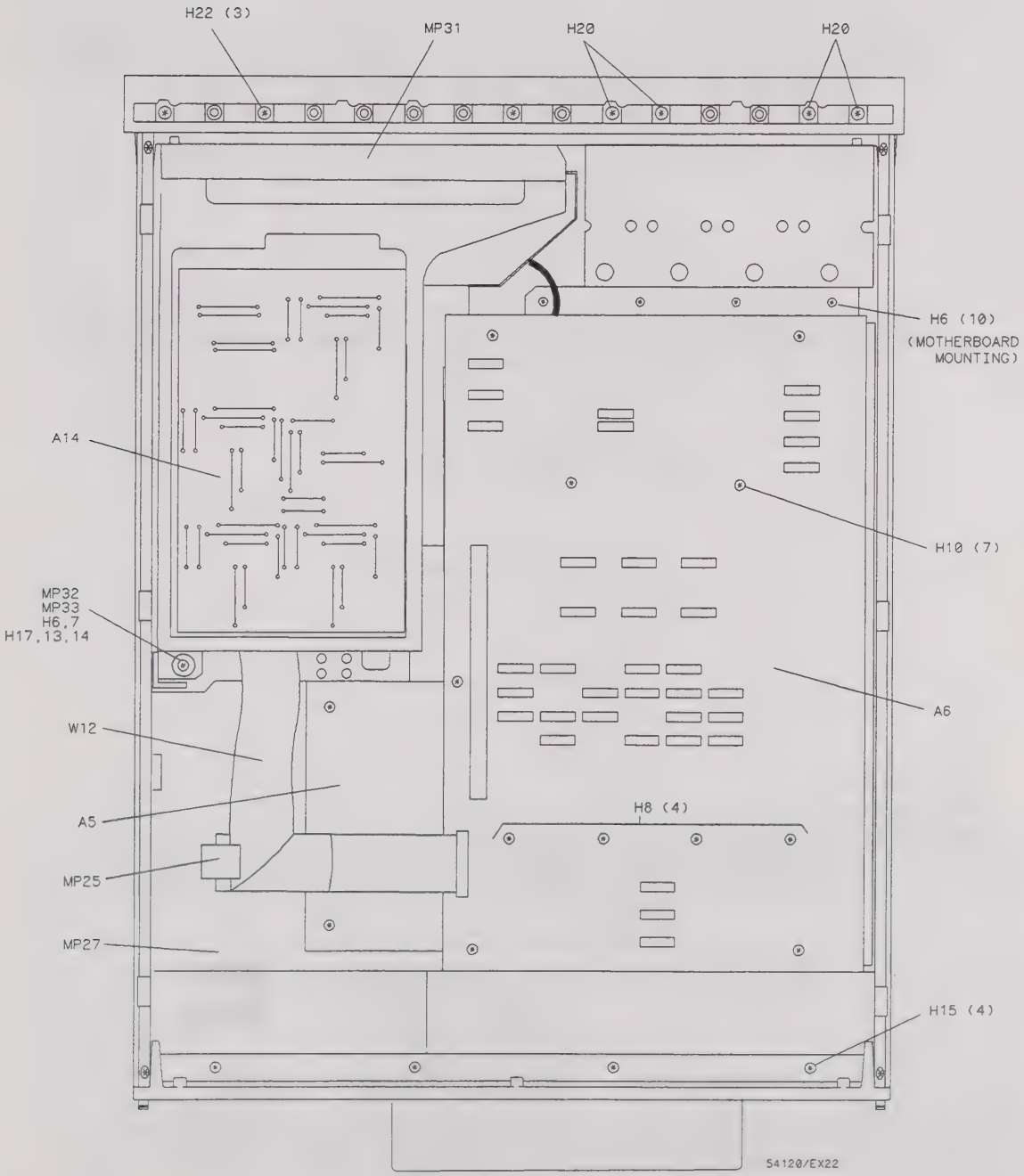

Figure 5-2. Bottom View

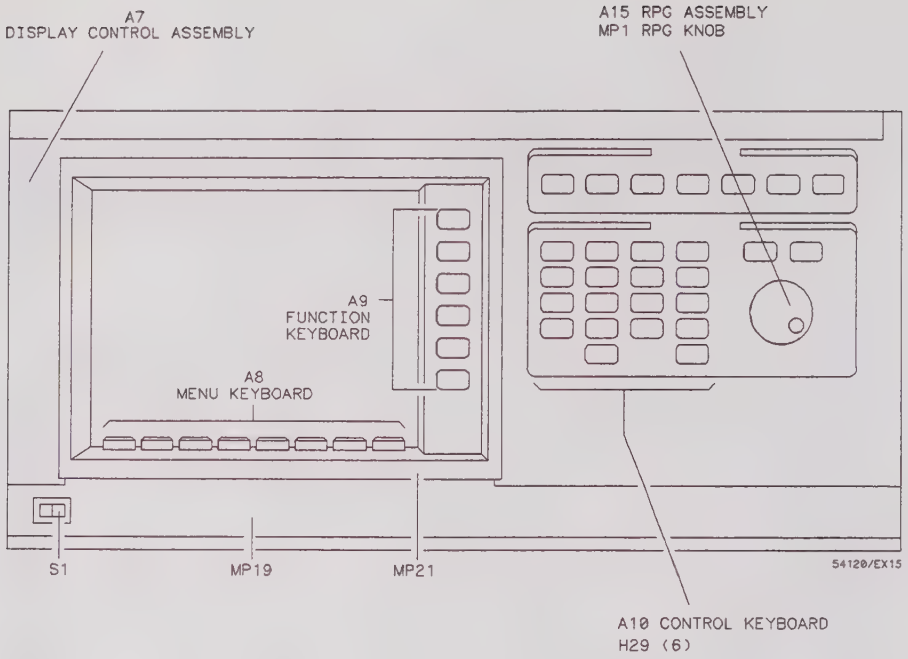

Figure 5-3. Front Panel

H5 Cover screw
H8 Retainer ring for cover screw
H9 Foot screw

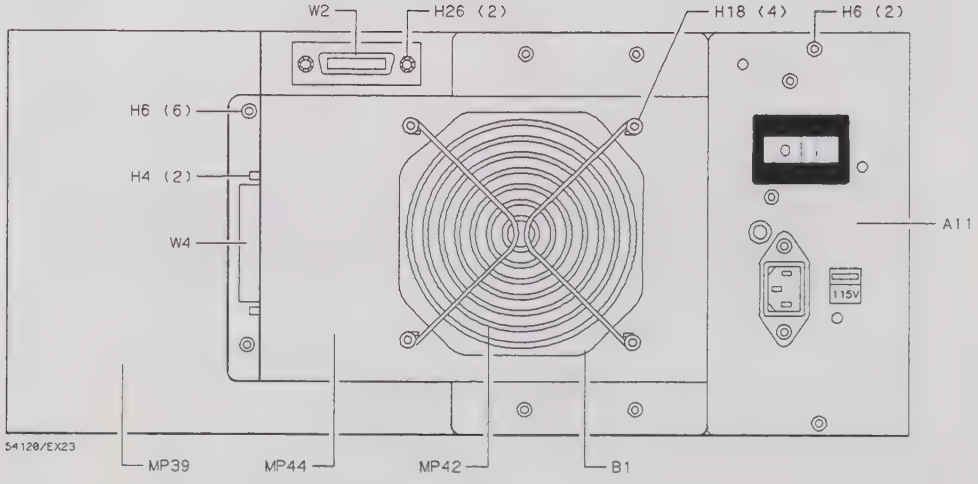

Figure 5-4. Rear Panel

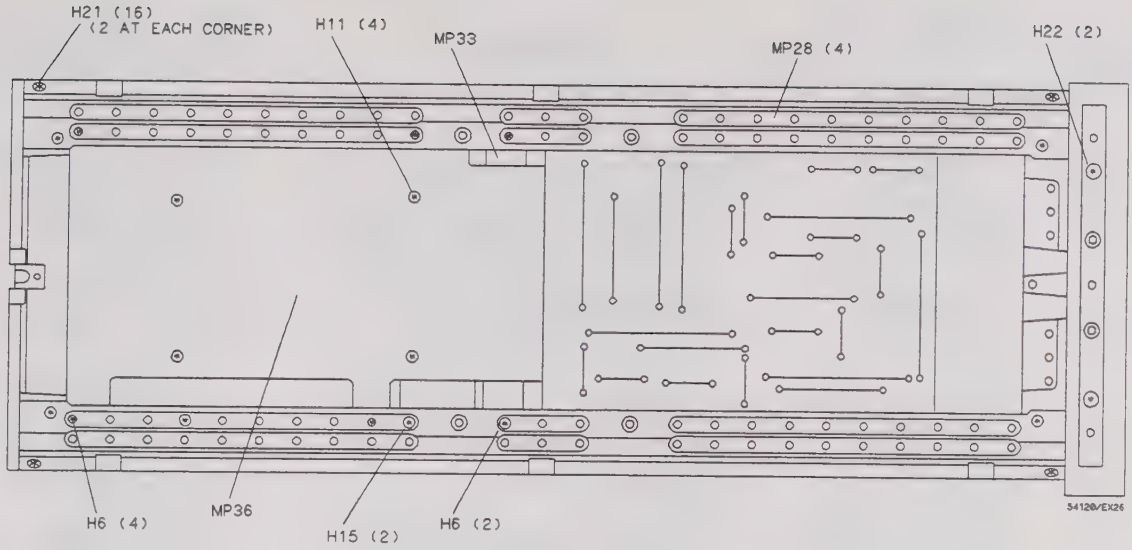

Figure 5-5. Left Side View

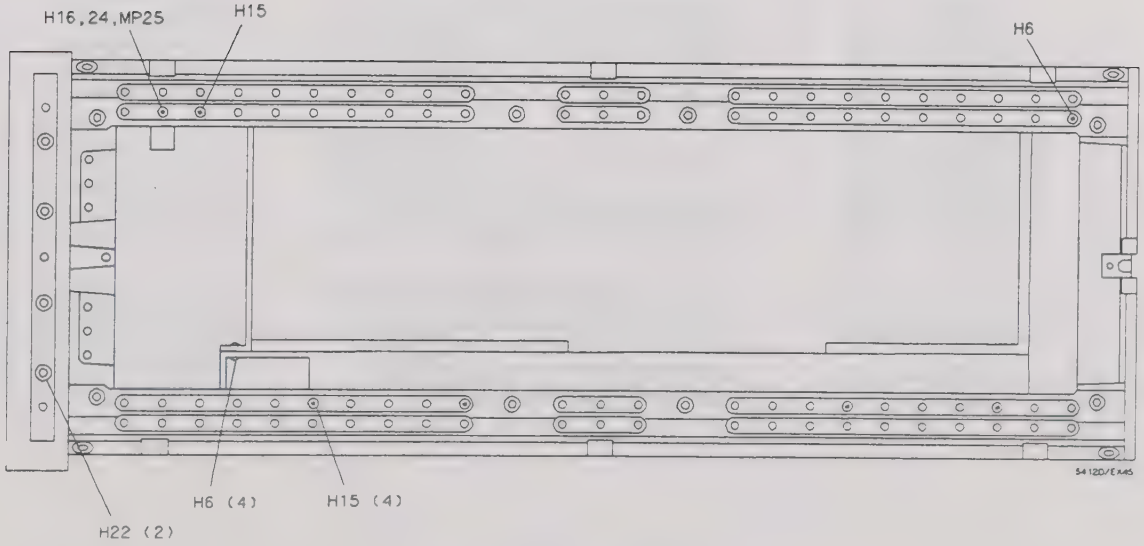

Figure 5-6. Right Side View

Table 5-3. Replaceable Parts List

Reference Designator	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
*EXCHANGE ASSEMBLIES						
*A1	54111-69506	8	0	I/O ASSEMBLY	28480	54111-69506
*A2	54111-69525	1	0	MICROPROCESSOR ASSEMBLY	28480	54111-69525
*A3	54122-69501	6	0	HORIZONTAL CONTROL ASSEMBLY	28480	54122-69501
*A4	54120-69502	5	0	ADC ASSEMBLY	28480	54120-69502
*A6	54110-69514	7	0	COLOR DISPLAY ASSEMBLY	28480	54110-69514
*A11	54110-69513	6	0	PRIMARY POWER SUPPLY ASSEMBLY	28480	54110-69513
*A12	54110-69510	3	0	ANALOG POWER SUPPLY ASSEMBLY	28480	54110-69510
*A13	54110-69506	7	0	DIGITAL POWER SUPPLY ASSEMBLY	28480	54110-69506
A1	54111-66506	2	1	I/O ASSEMBLY	28480	54111-66506
A2	54111-66525	5	1	MICROPROCESSOR ASSEMBLY	28480	54111-66525
A3	54122-66501	0	1	HORIZONTAL CONTROL ASSEMBLY	28480	54122-66501
A4	54120-66502	9	1	ADC ASSEMBLY	28480	54120-66502
A5	54110-66511	8	1	MOTHER BOARD ASSEMBLY	28480	54110-66511
A6	54110-66514	1	1	COLOR DISPLAY ASSEMBLY	28480	54110-66514
A7	54110-66509	4	1	CRT CONTROL ASSEMBLY	28480	54110-66509
A8	54100-66520	7	1	MENU KEYBOARD	28480	54100-66520
A9	54110-66502	7	1	FUNCTION KEYBOARD	28480	54110-66502
A10	54100-66505	8	1	CONTROL KEYBOARD	28480	54100-66505
A11	54110-66513	0	1	PRIMARY POWER SUPPLY ASSEMBLY	28480	54110-66513
A12	54110-66510	7	1	ANALOG POWER SUPPLY ASSEMBLY	28480	54110-66510
A13	54110-66506	1	1	DIGITAL POWER SUPPLY ASSEMBLY	28480	54110-66506
A14	2090-0092	3	1	COLOR CRT MODULE	28480	2090-0092
A15	01980-61062	5	1	RPG ASSEMBLY	28480	01980-61062
B1	3160-0521	3	1	FAN-TUBEAXIAL	28480	3160-0521
E1	8160-0577	4	1	RFI GROUND STRIP	28480	8160-0577
H1	0515-1384	8	2	SCREW-MACH M5 X 0.8 10MM-LG	28480	0515-1384
H2	0515-1444	1	4	SCREW-MACH M3.5 X 0.6 25.4MM-LG PAN-HD	28480	0515-1444
H3	0515-1319	9	8	SCREW-MACH M3 X 0.5 20MM-LG PAN-HD	28480	0515-1319
H4	1251-2942	7	2	SCREW LOCK KIT-SUBMIN D CONN	28480	1251-2942
H5	1251-1245	7	3	COVER SCREW	28480	1251-2945
H6	0515-0372	2	49	SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG	28480	0515-0372
H7	NOT ASSIGNED					
H8	0515-1253	0	3	RETAINER RING FOR COVER SCREW2	8480	0515-1253
H9	0515-1444	1	4	FOOT SCREW	28480	0515-1444
H10	0515-1410	1	7	SCREW-MACHINE ASSEMBLY M3 X 0.5 20MM-LG	28480	0515-1410
H11	0515-1025	4	4	SCREW-MACHINE ASSEMBLY M3 X 0.5 26MM-LG	28480	0515-1025
H12	5061-6138	2	4	NUT-INSERT M4 X 0.7 X 4.6 OD	28480	5061-6138
H13	2190-0763	7	2	WASHER-FL MTLC NO. 6 .14-IN-ID .5-IN-OD	28480	2190-0763
H14	3050-1238	8	2	WASHER-FL NM 9/64 .149-IN-ID .478-IN-OD	86928	3050-1238
H15	0515-0433	6	15	SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-0433

Table 5-3. Replaceable Parts List

Reference Designator	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
H16	NOT ASSIGNED					
H17	0515-0641	8	2	SCREW-THD-RLG M4 X 0.7 10MM-LG PAN-HD	28480	0515-0641
H18	0515-0435	8	4	SCREW-MACHINE ASSEMBLY M4 X 0.7 14MM-LG	28480	0515-0435
H19	NOT ASSIGNED					
H20	0515-1228	9	4	SCREW-MACH M4 X 0.7 6MM-LG 90-DEG-FLH-HD	28480	0515-1228
H21	0515-1403	2	16	SCREW-SPCL M4 X 0.7 6MM-LG 90-DEG-FLH-HD	28480	0515-1403
H22	0515-1269	8	16	SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-1269
H23	0535-0031	2	9	NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK	28480	0535-0031
H24	NOT ASSIGNED					
H25	2950-0043	8	1	NUT-HEX-DBL-CHAM 3/82THD .094-IN-THK	28480	2950-0043
H26	0380-1686	6	2	STANDOFF-HEX 6.5-MM-LG M3 X 0.5-THD	28480	0380-1686
H27	2190-0016	3	1	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
H28	3050-1176	3	1	WASHER-FL NM 3/8 IN .39-IN-ID .562-IN-OD	86928	3050-1176
H29	0515-0664	5	5	SCREW M3 12MN-L6 PAN-HP T10	28480	0515-0664
MP1	01650-47401	7	1	RPG KNOB	28480	01650-47401
MP2	5061-9448	3	1	BOTTOM COVER	28480	5061-9448
MP3	5040-7201	8	2	BOTTOM FEET	28480	5040-7201
MP4	5040-7222	3	2	BOTTOM NON SKID FEET	28480	5040-7222
MP5	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP6	8160-0590	1	2	GROUND RFI STRIP	28480	8160-0590
MP7	54110-04103	4	1	TOP COVER	28480	54110-04103
MP8	0890-0029	0	1	TUBING-HS .187-IN-D/.093-IN-RCVD	28480	0890-0029
MP9	5001-0441	2	2	TRIM STRIP SIDE	28480	5001-0441
MP10	5040-7202	9	1	TOP TRIM STRIP	28480	5040-7202
MP11	54110-40502	3	4	REAR FOOT	28480	54110-40502
MP12	5060-9948	6	1	LEFT SIDE COVER-PERFORATED	28480	5060-9948
MP13	5061-9523	5	1	RIGHT SIDE COVER-PERFORATED	28480	5061-9523
MP14	5060-9805	4	1	STRAP HANDLE	28480	5060-9805
MP15	5041-6819	4	1	FRONT CAP FOR STRAP HANDLE	28480	5041-6819
MP16	5041-6820	7	1	REAR CAP FOR STRAP HANDLE	28480	5041-6820
MP17	NOT ASSIGNED					
MP18	5021-5807	6	1	FRONT FRAME	28480	5021-5807
MP19	54120-00206	2	1	FRONT PANEL	28480	54120-00206
MP20	54111-00203	8	1	FRONT SUB PANEL	28480	54111-00203
MP21	54110-40501	2	1	DISPLAY BEZEL	28480	54110-40501
MP22	16500-00603	3	1	FAN SCREEN	28480	16500-00603
MP23	0403-0092	6	1	BUMPER FOOT-PRS-IN	28480	0403-0092
MP24	1400-1362	0	2	CLAMP-CABLE .35-DIA .51-WD NYL	28480	1400-1362
MP25	1400-0611	0	2	CLAMP-FL-CA 1-WD	06915	1400-0611
MP26	54111-01203	0	1	FRONT CARD CAGE BRACKET	28480	54111-01203
MP27	54111-00101	5	1	MAIN DECK	28480	54111-00101
MP28	5021-5838	3	4	SIDE STRUT	28480	5021-5838
MP29	NOT ASSIGNED					
MP30	54110-01201	7	1	TOP CRT BRACKET	28480	54110-01201

Table 5-3. Replaceable Parts List

Reference Designator	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
MP31	54110-01202	8	1	BOTTOM CRT BRACKET	28480	54110-01202
MP32	54110-01210	8	1	BRACKET-COLOR CRT MOD. REAR-ON MODULE	28480	54110-01210
MP33	54110-04702	9	1	BRACKET-COLOR CRT MOD. REAR-ON FRAME	28480	54110-04702
MP34	1400-0679	0	4	CLIP-CABLE 'U' SHP, PNL MTG TYPE	28480	1400-0679
MP35	54111-04104	6	1	POWER SUPPLY COVER-TOP	28480	54111-04104
MP36	54110-04106	7	1	POWER SUPPLY COVER-SIDE	28480	54110-04106
MP37	5021-5808	7	1	REAR FRAME	28480	5021-5808
MP38	54110-94302	4	1	WARNING LABEL	28480	54110-94302
MP39	54120-00201	7	1	REAR PANEL	28480	54120-00201
MP40	54111-05201	6	1	AIR PLENUM	28480	54111-05201
MP41	7120-4835	0	1	LABEL-INFORMATION .75-IN-WD 2-IN-LG PPR	28480	7120-4835
MP42	3160-0092	3	1	FAN GUARD	28480	3160-0092
MP44	54120-04103	6	1	FAN COVER	28480	54120-04103
MP45	54120-04702	1	1	FAN SPACER	28480	54120-04702
S1	3101-2911	5	1	ROCKER SWITCH (STANDBY)	28480	3101-2911
W1	8120-1521	6	1	POWER CABLE	28480	8120-1521
W2	54100-61602	6	1	HPIB CABLE	28480	54100-61602
W3	54120-61618	8	1	UMBILICAL CABLE 2 METRE	28480	54120-61618
W4	54120-61612	2	1	MAINFRAME CABLE ASSEMBLY	28480	54120-61612
W5	54100-61601	5	1	RIBBONCABLE-I/O TO FRONT PANEL	28480	54100-61601
W6	54100-61612	8	2	CABLE AC BD CO ANAL & DIG BD	28480	54100-61612
W7	NOT ASSIGNED					
W8	54110-61601	7	1	3 WIRE CABLE - COLOR DISPLAY MODULE POWE	28480	54110-61601
W9	54111-61610	9	1	POWER SWITCH CABLE 2 WIRE-FRONT PANEL ST	28480	54110-61610
W10	54111-61611	0	1	2 WIRE CABLE-REAR CABLE STBY SWITCH	28480	54111-61611
W11	54110-61611	9	1	DISPLAY CONTROL CABLE	28480	54110-61611
W12	54110-61607	3	1	RIBBON CABLE DISP ASSY TO COLOR MODULE	28480	54110-61607

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Disassembly 6A

Introduction

This section contains removal and replacement procedures for HP 54120B Digitizing Oscilloscope Mainframe assemblies.

Safety Considerations

The following warnings and cautions must be followed for your protection and to avoid damage to the equipment.

Warning

This instrument is equipped with a standby switch on the front panel that DOES NOT de-energize the power supply. To avoid shock hazards capable of causing injury or death, the main power switch on the rear panel must be used to de-energize the instrument or the power cable must be disconnected when the instrument must be de-energized.

Warning

These procedures are used while repairing an instrument that has protective covers removed and may have had power applied. Maintenance should be performed only by trained service personnel who are aware of the hazards involved (for example, fire and electrical shock). Read the Safety Summary in the front of this manual.

Caution

Do not remove or replace any of the circuit board assemblies in the instrument unless instrument power is removed. The boards contain components which may be damaged if the board is removed or replaced when instrument power is applied.

Tools Required

The hardware requires TORX™ type tools for removal and replacement. Sizes required for the procedures in this section are #10 and #15. A medium posi drive is used for the top cover.

If the display must be replaced, an 8 mm wrench or driver is also required.

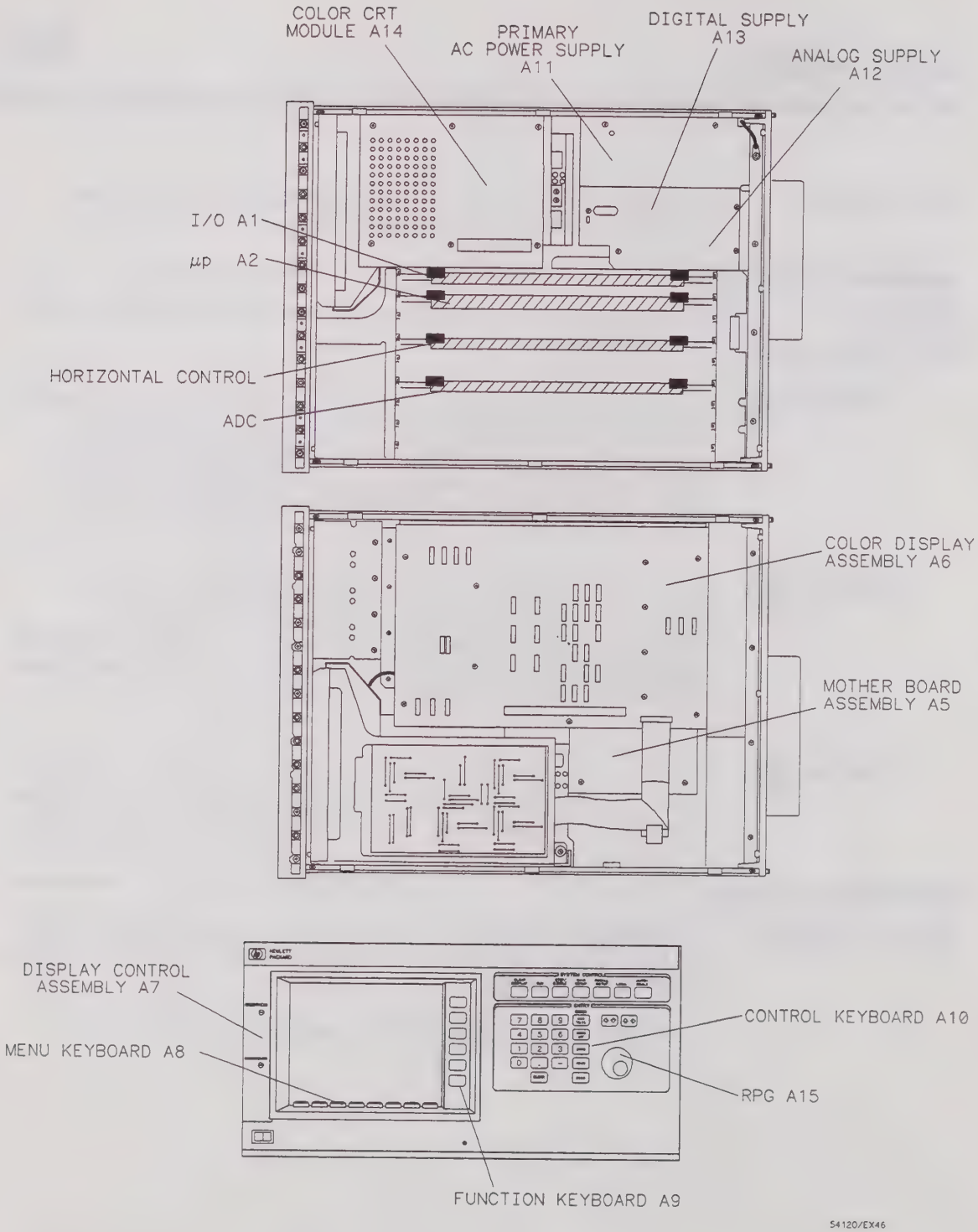

Figure 6A-1. Major Assembly Locations

Card Cage PC Assemblies

The following procedures should be followed when disassembling the instrument. Particular care should be taken when inserting the card cage assemblies into the mainframe to avoid bending the connector pins. There are only four cables connecting to the card cage assemblies. These four cables are different in size and their proper connection is easily determined.

Removal

1. Disconnect power cable.
2. Remove top rear feet and top cover.
3. Disconnect any cables from assembly to be removed.
4. Refer to the illustration on top of the power supply shield. Release PC assembly by pulling the flexible plastic extractors away from the assembly shield, then up.
5. Remove the assembly from the connector by pulling up on the extractors.

Replacement

1. Insert PC assembly shield edges in proper guides.
2. Keep the extractors up while sliding the assembly in.
3. While keeping assembly properly aligned in guides, push it in. As the top edge of the assembly becomes level with the top of the card cage the connector will start to engage. Keep assembly level and apply even pressure until connector is seated.
4. Reconnect all cables which were disconnected from any assemblies.

Caution

Do not use the extractors to lever the assembly into the connector. Using the extractors makes it too easy to apply excessive force that might bend misaligned connector pins. If the connector will not seat, remove the assembly and check for bent pins. Bent pins are very expensive and time consuming to replace on the motherboard SIB connector. Avoid pinching cables between the assembly and the mainframe.

Primary Supply

Removal

1. Disconnect power cable.
2. Remove rear feet from top right corner and left side.
3. Remove top and left side covers.

Caution

Hazardous voltages capable of causing injury or death are present when the power supply shields are removed and AC power is applied to the instrument. To avoid this hazard make sure the AC power cable is disconnected before continuing with this procedure.

4. Through the hole in the top power supply shield, observe the red LED on the primary power supply. This LED indicates the presence of 300 volts. It will stay illuminated until the filter capacitors discharge. Wait until this LED is no longer illuminated before proceeding (approximately three minutes).
5. Remove top power supply shield (six screws).
6. Remove the screw that attaches the ground wire (green/yellow) to top corner of rear frame.
7. Remove the three cables at the top front of the primary power supply PC assembly.
8. Remove four screws from power supply side cover. Refer to figure 6A-2.
9. Remove two screws which attach power supply assembly to rear panel. Refer to figure 6A-2.

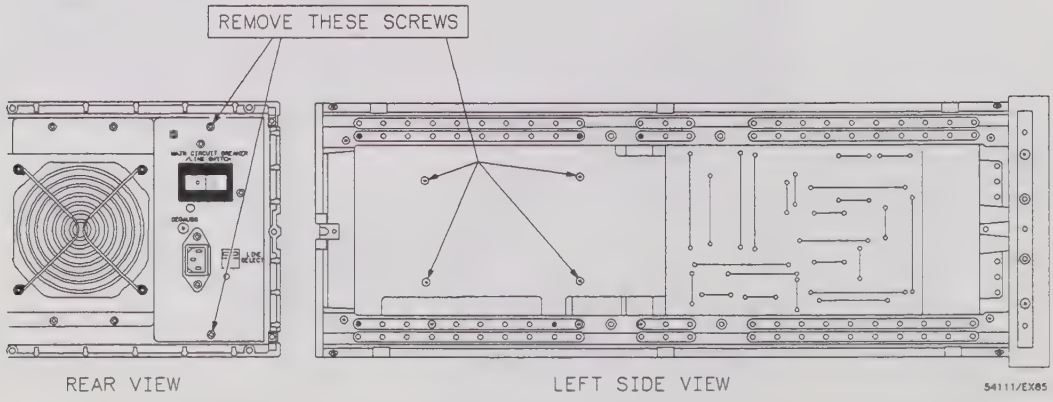

Figure 6A-2. Primary Power Supply Mounting Screws

10. Turn instrument onto its left side. Pull the power supply assembly rearward until the STBY switch cable at the rear of power supply assembly can be disconnected. Disconnect the cable.

11. Pull supply rearward until it clears the instrument.

Replacement

1. Reverse removal procedure to install supply.

Warning

Power supply safety grounding will be defeated if ground wire removed in step 6 above is not reconnected. To avoid a defeated ground, make sure the green/yellow wire is re-attached to top rear corner of the rear frame.

Analog Supply

Removal

1. Disconnect power cable.

2. Remove top rear feet and top cover.

Warning

Hazardous voltages capable of causing injury or death are present when the power supply shields are removed and AC power is applied to the instrument. To avoid this hazard make sure the AC power cable is disconnected before continuing with this procedure.

3. Through the hole in the top power supply shield, observe the red LED on the primary power supply. This LED indicates the presence of 300 volts. It will stay illuminated until the filter capacitors discharge. Wait until this LED is no longer illuminated before proceeding (approximately three minutes).

4. Remove top power supply shield (six screws).

5. Disconnect the analog power supply input cable from the top front corner of the primary power supply.

6. Use a flat-blade screwdriver to loosen the captive screw at the bottom front of the supply.

7. It may be easier to remove the analog supply by first removing the I/O assembly from the mainframe. However, this will cause a loss of all front panel cals, any stored front panel setups, and all stored waveforms.

8. Release power supply board connector by pulling board straight up and off the guide posts.

Replacement

1. Reverse the removal procedure to install assembly.

Digital Supply

Removal

1. Disconnect power cable.

2. Remove top rear feet and top cover.

Warning

Hazardous voltages capable of causing injury or death are present when the power supply shields are removed and AC power is applied to the instrument. To avoid this hazard make sure the AC power cable is disconnected before continuing with this procedure.

3. Through the hole in the top power supply shield, observe the red LED on the primary power supply. This LED indicates the presence of 300 volts. It will stay illuminated until the filter capacitors discharge. Wait until this LED is no longer illuminated before proceeding (approximately three minutes)

4. Remove top power supply shield (six screws).

5. Disconnect the Digital Power Supply input cable from the top front corner of the Primary Power Supply.

6. Use a flat-blade screwdriver to loosen the captive screw at the front bottom of the supply.

7. Release power supply board connector by pulling board straight up and off guide posts.

8. Remove the supply from instrument by lifting front edge of board first then rotating board up and out.

Replacement

1. Reverse removal procedure to install board.

CRT Bezel

The keyboards at the side and bottom of the CRT can be removed by first removing the CRT bezel.

Removal

1. While pushing down on top edge of bezel Refer to figure 6A-3, pull top edge away from front panel until holding tabs are clear of the front panel.
2. Lift bezel slightly and pull bottom of bezel away from front panel.
3. Pull bezel away from front panel just far enough to gain access to the ribbon cable connectors on control keyboard. They are just to the right of the bezel opening in the front panel.
4. Disconnect the two ribbon cable connectors from the control keyboard.

Function & Menu Keyboards

5. If either the function or menu keyboard needs replaced, they are each attached to the bezel with two screws.

Replacement

1. Reverse the removal procedure to install bezel.

Note

The ribbon cables must be reconnected as follows: function keyboard cable (right side of bezel) to top connector on control keyboard and menu keyboard cable (bottom of bezel) to bottom connector on control keyboard.

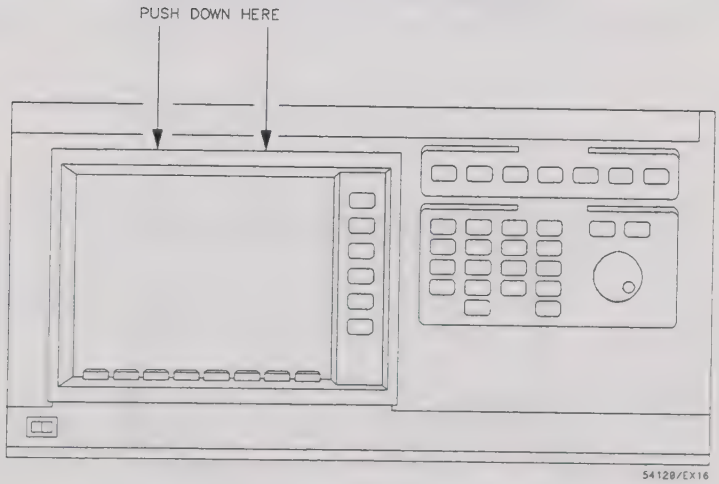

Figure 6A-3. CRT Bezel Removal Pressure Locations

Front Panel

Use steps 1 through 10 to remove front panel, steps 1 through 11 to remove display control, and steps 1 through 10 and steps 12 and 13 to remove control keyboard.

Note

It is not necessary to remove the front panel to remove the keyboards around the CRT bezel. See the previous removal procedure.

Removal

1. Disconnect power cable.
2. Remove rear feet and top, bottom, and side covers.
3. Remove top, and side trim strips from the front frame by carefully prying up at the strip's ends with a flat blade screwdriver.
4. Remove two front panel screws that are under each side trim strip.
5. Remove six front panel screws as shown in figure 6A-4.

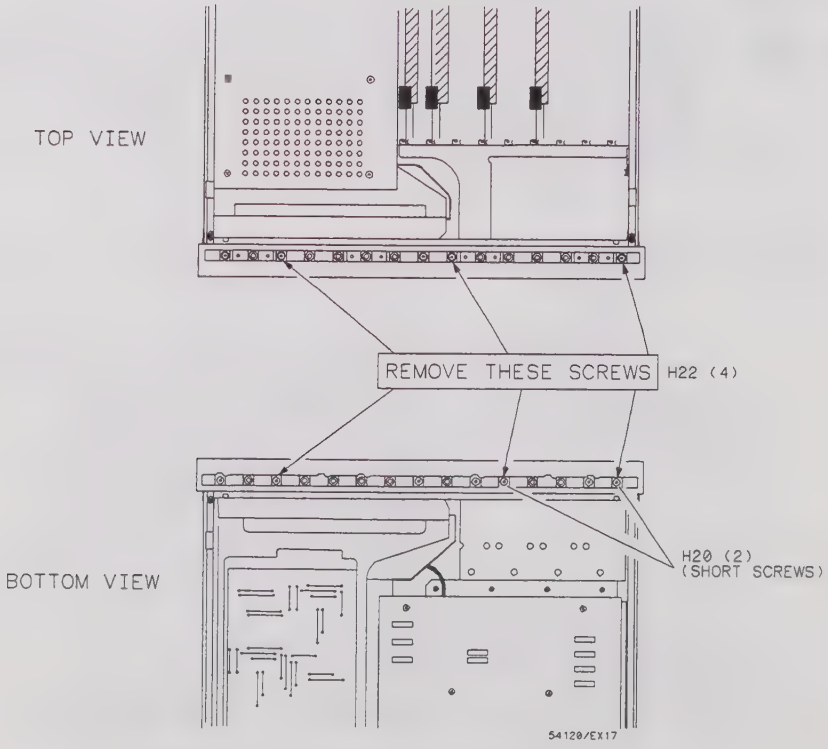

Figure 6A-4. Front Panel Mounting Screws

6. Set instrument in its normal operating position.

7. Disconnect the STBY switch by separating the two-wire interconnect just to the right of the CRT.

8. Pull front panel just far enough to gain access to the cable connector on the CRT control board (left side of front panel) and disconnect the cable.

9. Open the two cable ties: top left, inside front panel and top right of CRT, and remove the cables.

10. Disconnect the large ribbon cable from the control keyboard and remove the front panel from the instrument.

Display Control

11. Remove two screws attaching the display control assembly.

Control Keyboard

12. Disconnect the RPG cable at the control keyboard and the two cables from the CRT bezel keyboards.

Note

The menu keyboard (right side of bezel) cable connects to the top connector and the function keyboard (bottom of bezel) cable connects to the bottom connector on the control keyboard.

13. Remove five screws to remove the board.

14. Pass RPG cable through hole in control keyboard.

Replacement

1. Reverse the procedure to replace any of these assemblies.

Color CRT Module Removal

The color CRT module is replaceable only as a complete unit.

1. Remove front panel. Refer to front panel removal paragraph.
2. Disconnect the flat wide ribbon cable from the color display assembly and remove cable from clip.
3. Remove four screws that attach the color display module to the front frame. Refer to figure 6A-5.
4. Remove two screws attaching side of module to left side corner struts. Refer to figure 6A-5.
5. Slowly pull module forward until the power cable (small three-wire) can be disconnected at the primary power supply board.
6. Continue pulling module forward until it clears the instrument.

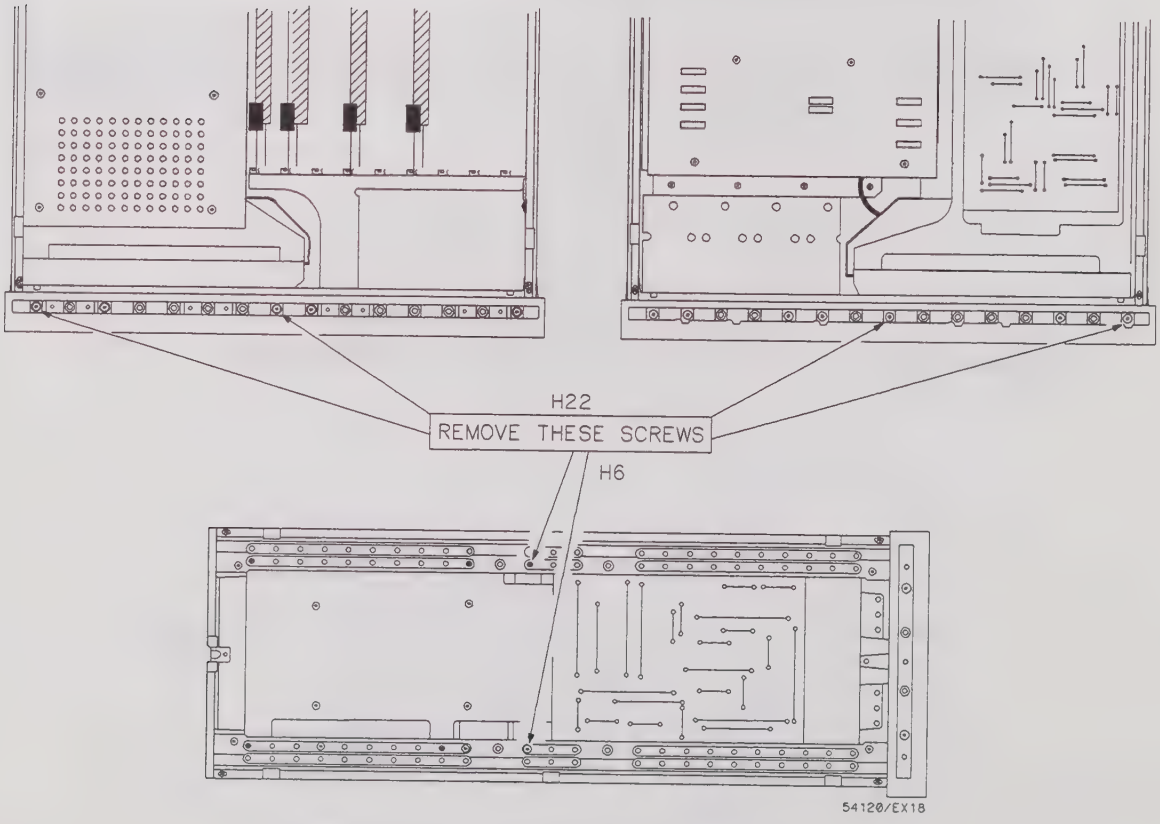

Figure 6A-5. Color CRT Module Mounting Screws

Replacement

It is necessary to use the following procedure to remove several items from the inoperative color CRT module and install them on the new one. These parts are not included with a new color monitor module.

Transfer Parts To New Module

1. Remove the eight small screws that hold the shield to the top and side of the inoperative module.

Note

These screws are special self-tapping screws, different from the screws in the rest of the instrument. They must be used for mounting the shield on the new module. Do not use them for any other purpose.

2. Use an 8 mm wrench to remove the four nuts on the front of the inoperative module and remove the shield.

3. Remove the front mounting brackets and put the 8 mm nuts back on the module.

4. Remove the 8 mm nuts from the new module, do not remove any other hardware, and install the front mounting brackets.

5. Install the shield on the new module. Place it over the two front mounting screws and front mounting brackets.

6. Install the four 8 mm nuts but leave them loose so the shield can move.

7. Use the special self-tapping screws (step 1) to fasten the top and side of the shield. They will be hard to start while they are tapping the holes. Be careful that excessive tightening does not strip the self-tapped holes.

8. Tighten the 8 mm nuts at the front of the module.

9. The rear bracket is two brackets connected together by shock mounting hardware. Remove the two screws that hold the bracket assembly to the rear of the inoperative module.

Note

These screws are special self-tapping screws that must be used for mounting the bracket assembly on the new display. Do not use them for any other purpose.

10. Mount the rear bracket assembly on the new module. The screws will be hard to start because they must self-tap the mounting holes. Be careful that excessive tightening does not strip the self-tapped holes.

11. Note the routing of the power cable and CRT control cable and one at a time, remove them and install them on the new module.

12. Remove the wide flat ribbon cable from the old module and install it on the new one.

Install New Module

13. Install the new module most of the way into the instrument. Avoid pinching cables as module is being installed.

14. Connect the power cable to the appropriate connector at the top front corner of the primary power supply and slide module the rest of the way in.

15. Install, but do not tighten, the two rear and four front mounting screws. Refer to figure 6A-5.

16. Install the front panel. Use the steps given in the front panel procedure except for steps 3, 2, and 1.

17. Push the module forward, closing as much as possible the gap between the CRT and the bezel. Tighten the two rear and four front mounting screws.

18. Complete the rest of the instrument assembly by doing steps 3, 2, and 1 of the front panel procedure.

Fan

Removal

1. Disconnect power cable.
2. Remove bottom rear feet and bottom cover.
3. Disconnect fan power cable from rear corner of motherboard.
4. Remove fan housing mounting screws as shown in in the figure 6A-6.
5. While noting fan cable routing, carefully remove fan housing from instrument.

Replacement

1. Reverse removal procedure to install fan. Be sure fan power cable does not get pinched between fan and rear panel.

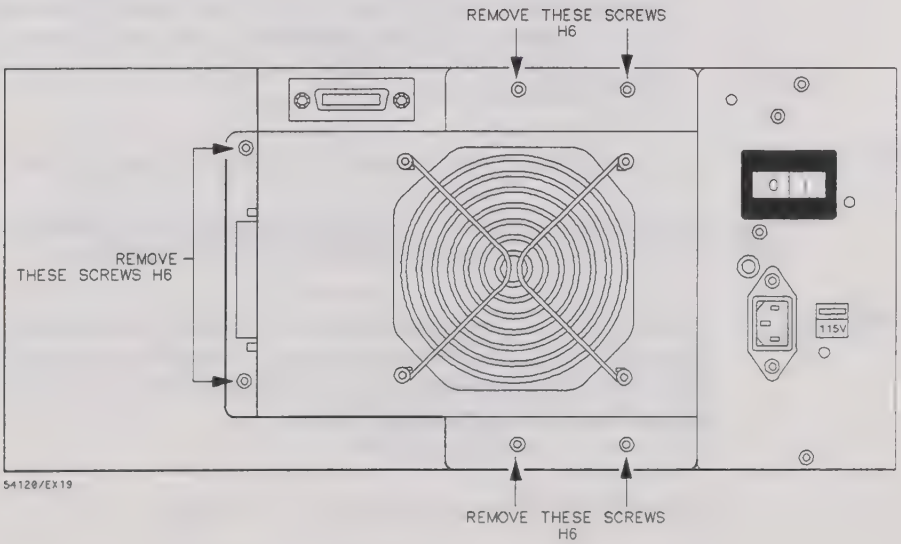

Figure 6A-6. Fan Housing Mounting Screws

Color Display Assembly

Removal

1. Disconnect power cable.
2. Remove bottom rear feet and bottom cover.
3. Disconnect wide ribbon cable from color display assembly.
4. Refer to figure 6A-7 to remove eleven assembly mounting screws.
5. Carefully lift board straight up to disengage motherboard connector.

Note

The display assembly to motherboard connector will exhibit some removal resistance while the board is being removed. It is recommended the major lifting force be exerted on the edge of the color display assembly at the connector.

6. Note the "comb" type connector used between the color display assembly and motherboard. It consists of two separate combs held in place on the color display assembly by a connector guide and two screws. If the assembly is being replaced, this connector guide and the two comb connectors must be removed from the old assembly and installed on the new one. The connector DOES NOT come with the new assembly.

Replacement

1. Install the comb connectors and connector guide on color display Assembly.
2. Reverse removal procedure to install assembly. Use additional care when inserting the connector pins into connector on motherboard.

Note

Power for the color display assembly is obtained from the motherboard by the four short mounting screws. Their positions are marked +5 and GD on the board. These mounting screws must be installed and tightened before proper operation of the instrument can be expected.

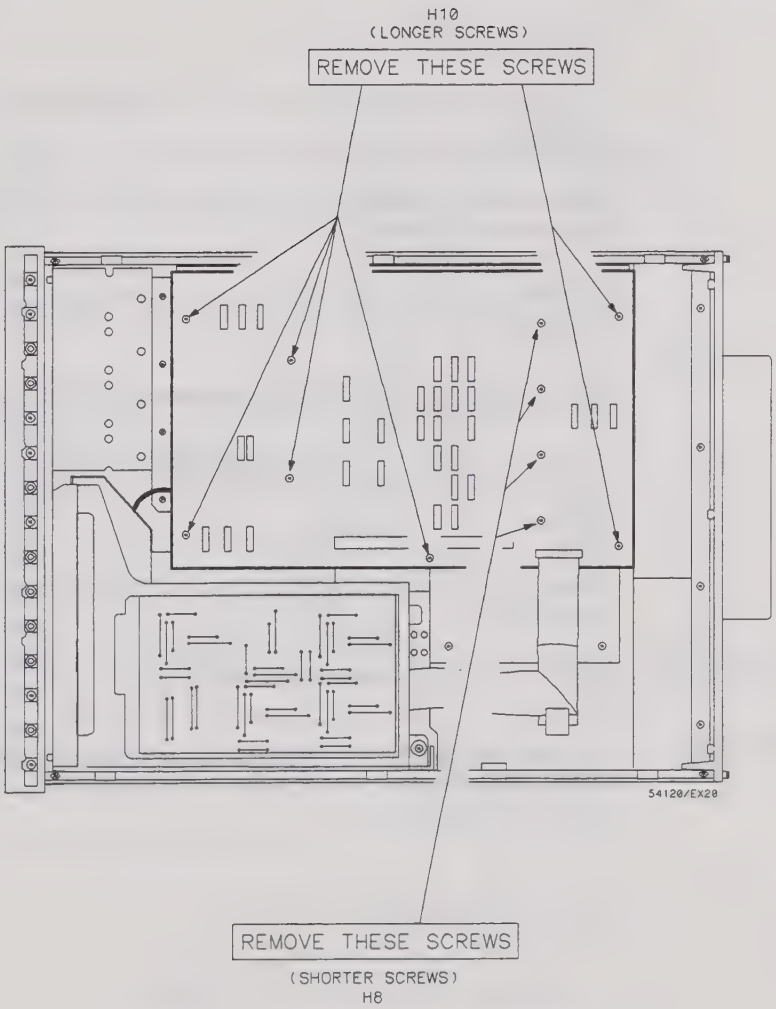

Figure 6A-7. Color Display Assembly Mounting Screws

Motherboard

Removal

1. Disconnect power cable.
2. Remove rear feet and all covers.
3. Remove all card cage PC boards. Refer to card cage assembly removal paragraph.
4. Remove analog power supply and digital power supply. Refer to digital power supply removal paragraph.
5. Remove color display assembly. Refer to color display assembly removal paragraph.
6. Disconnect fan power cable connector from rear corner of motherboard.
7. Loosen the STBY switch cable by removing the two nylon cable clamps from bottom of motherboard. Squeeze the clamps and pull them from the holes in the board.
8. Remove the remaining mounting screws and remove board. Refer to figure 6A-8.

Replacement

1. Reverse removal procedure to install board.

Note

The motherboard and display board share some of the same mounting screws. Therefore, when installing the motherboard install only the screws removed in step 8 above. Refer to figure 6A-8.

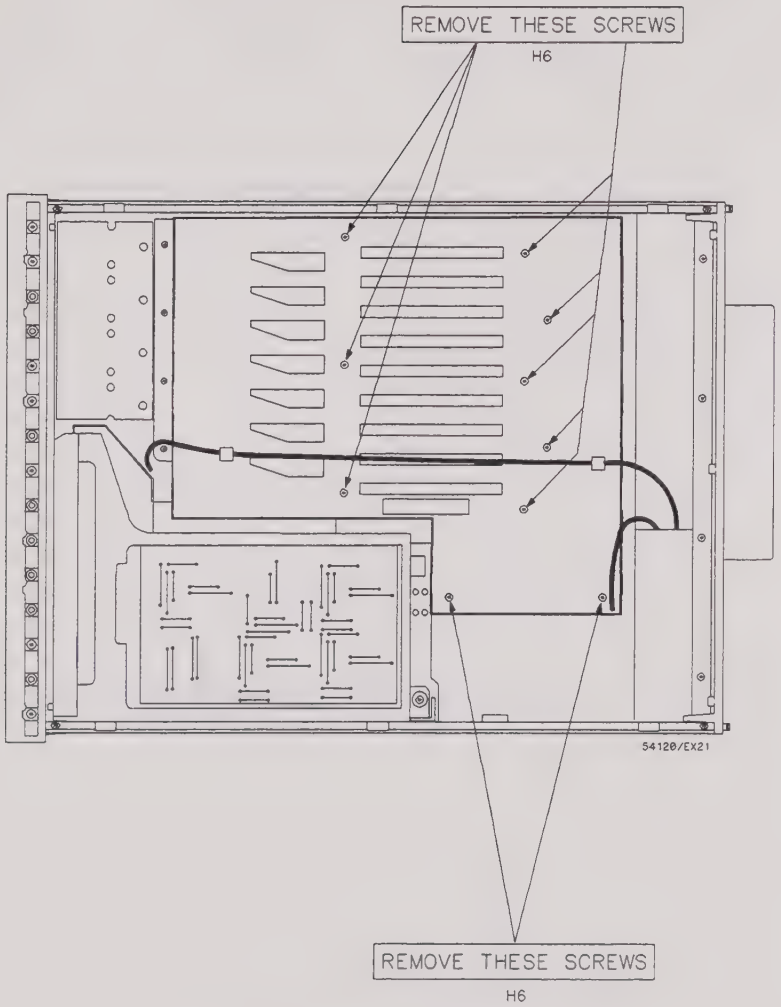

Figure 6A-8. Motherboard Mounting Screws

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Theory 6B

Introduction

This section is the theory of operation for the HP 54120B Digitizing Oscillosocpe Mainframe. It includes overall system block diagrams and system theory of operation, printed circuit assembly (PCA) block diagrams and PCA block level theory of operation.

System Theory

This theory of operation refers to the System Block Diagram, figure 6B-1. It includes the mainframe and four channel test set, and is presented in block diagram format with a brief description of each block's basic functions. The theory's purpose is to help give a basic understanding of the instrument's overall operation as an aid in troubleshooting to the board level.

Motherboard

Each of the four card cage assemblies (A1 through A4) plug into the motherboard (A5). The 9 motherboard connectors each have a hard-wired identification code (0 through 8). Each plug-in assembly has a built-in identification code. Therefore, any assembly can be placed in any motherboard connector and the microprocessor (CPU) can identify what type of assembly is in each slot. This information can be displayed on the HP 54120B CRT by pressing **Utility** menu, then **Test** menu, then **Display Configuration**. Note that the microprocessor's position is displayed as an empty slot. The factory configuration is the preferred assembly locations. For troubleshooting purposes, any assembly may be temporarily placed in any location. However, some cables may be too short to reach all motherboard locations.

Power Supplies

There are three power supply assemblies within the HP 54120B mainframe system. The primary power supply (A11) receives its input from the power line on the rear panel. The rear panel contains an EMI (electromagnetic interference) circuit and the main circuit breaker. The primary power supply contains voltage regulation to output 300 volts used by the analog supply (A13) and digital supply (A12), and 120 volts used by the color CRT module A14. The analog power supply regulates the 300 volt input, and supplies ± 18 volts and ± 8 volts for the instrument's analog circuits. The digital power supply regulates the 300 volts to supply ± 5 volts for the instrument's digital circuits. Both of these power supplies have their own ground systems which are isolated from each other. Therefore, voltage measurements must be made to the proper common points.

Front Panel Interface

The front panel contains system control keys, softkeys, a keypad, and a knob. All these devices are on or wired through the control keyboard (A10). All information from the control keyboard is input to the I/O assembly through a large ribbon cable connected near the front of the I/O assembly. The keypad and softkeys are set up in a matrix so that the I/O assembly can scan the lines of keys by outputting a pulse on each line. If a key is closed (pressed), the I/O assembly will detect the return of the pulse on another line. By knowing which line the pulse was output on and which line the pulse was returned on, the I/O assembly can determine which key was pressed. These key scan lines are passed through the large ribbon cable from the I/O assembly.

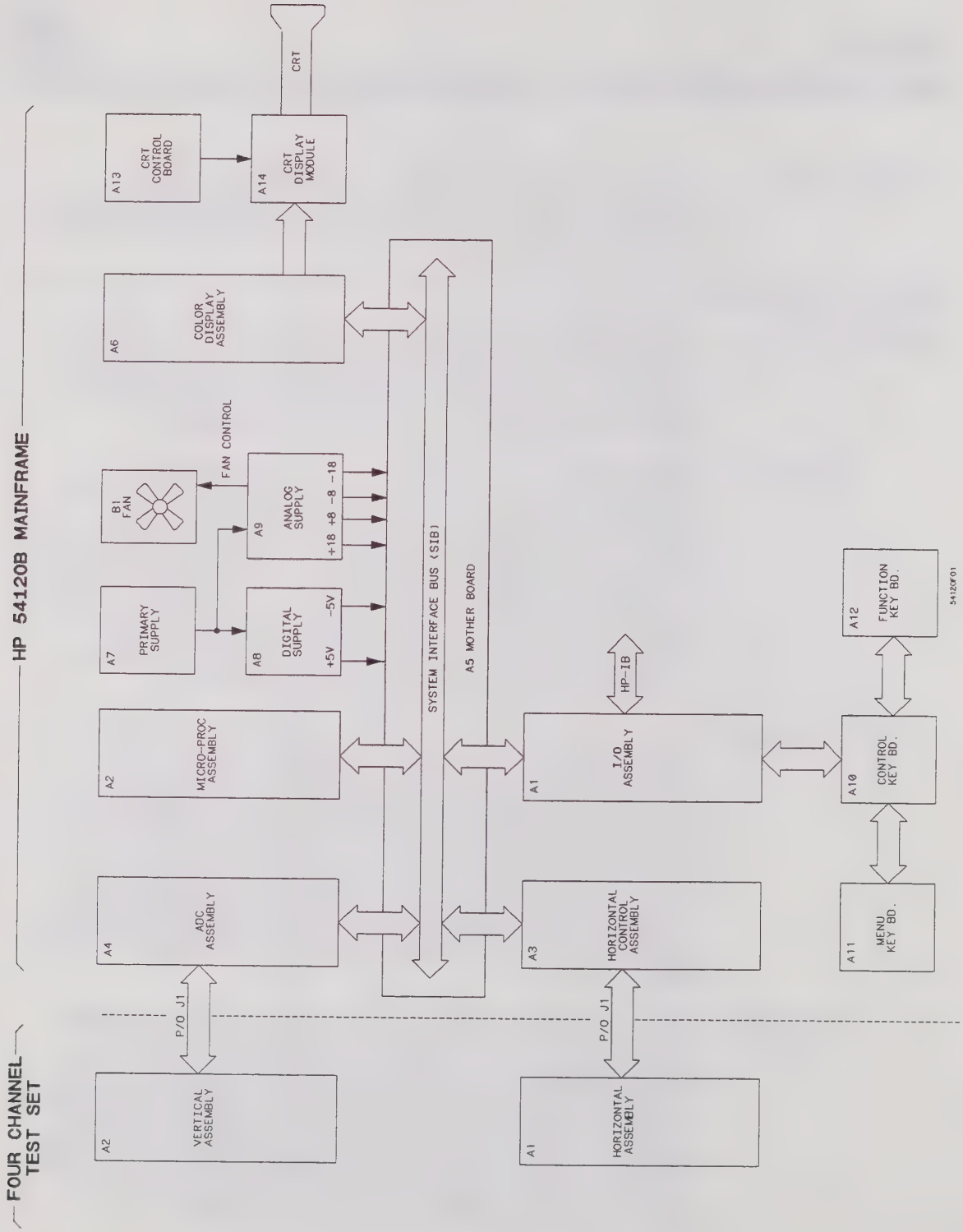

Figure 6B-1. System Block Diagram

Display System

The color CRT module receives horizontal and vertical sync pulses, and character and graphics data from the color display assembly (A6). These signals are connected to the color CRT module through a ribbon cable from the side of the color display assembly. The color CRT module creates the sweep signals, blanking, and voltages required to display information on the CRT.

HP-IB System

The HP-IB connector on the rear panel of the instrument is connected by a ribbon cable to the top rear of the I/O assembly. The I/O assembly contains an HP-IB interface integrated circuit to convert data to proper HP-IB format

System Interface Bus

All digital data is moved between the HP 54120B mainframe assemblies over the system interface bus (SIB). The SIB has data, address, and control lines all under the CPU's control. Many of the assemblies have a local data bus (LDB) which is under the assembly's own control. The SIB and the local data buses must not be confused. In most cases data and addresses are accepted by an assembly from the SIB under CPU control, then the data is manipulated by that assembly on its local data bus.

Microprocessor (CPU) Assembly

The microprocessor assembly has a 68000 microprocessor, 384k bytes of ROM, 32k bytes of non-volatile RAM (battery back-up), programmable timer, and bus request/bus grant circuits. The assembly has an internal data bus, so it can process data without tying up the System Interface Bus. Data is moved on the SIB under control of the 68000 microprocessor. The assembly also has logic circuits so it can operate with another microprocessor on the SIB, in which case the bus request/bus grant circuits would be used. In the HP 54120B only one microprocessor is used, therefore the bus request/bus grant signals are tied to the proper logic levels so the 68000 microprocessor will have control of the SIB when required.

Display Assembly

The display assembly has 128k bytes of dynamic RAM (DRAM) used as the dot memory to store signal data to be displayed. It also has a character generator and character refresh circuits for the characters that will be displayed. The assembly produces vertical and horizontal sync signals so signal and character data are displayed on the CRT at the proper place and time.

I/O Assembly

The I/O assembly has interface circuits to read the front panel devices, including softkeys, knob, system control keys, and keypad. The assembly also has HP-IB interface logic, clock circuit which produces the required microprocessor clocks, power on reset circuit which resets the microprocessor, additional CPU dynamic RAM memory, other logic which starts up the CPU to a known condition, and a battery which powers the non-volatile RAM on the CPU assembly.

Horizontal Control Assembly

A user inputs various timebase and trigger selections to the HP 54120B. The CPU communicates these selections and acquisition control signals to the horizontal control assembly over the SIB. The horizontal control assembly translates these CPU instructions into various trigger and timebase signals for the horizontal and vertical assemblies located in the four channel test set. These signals control the sampling and data acquisition process. An acquisition cycle is defined as the sequence of events that must occur in order to acquire a single data point per enabled channel. It will normally be the case that several acquisition cycles will be required to adequately display a waveform.

Horizontal Assembly (located in test set)

The horizontal assembly has the trigger and timebase hybrids. After a trigger occurs and delay has reached terminal count, the horizontal assembly enables the sample pulse generator. The sample pulse generator momentarily turns the samplers on. Block diagram and theory is in the test set manual.

Vertical Assembly (located in test set)

The vertical assembly momentarily samples incoming signals during a very narrow time window, 17 ps. It then amplifies and converts the sample to a bipolar pulse. A bipolar pulse is easier for the ADC assembly's track and hold circuitry to follow the pulse's peak amplitude. Block diagram and theory is in the test set manual.

ADC Assembly

The ADC assembly has track and hold circuitry which tracks the bipolar pulse's amplitude and holds the peak value. It also contains an analog to digital converter which converts incoming analog signals into a digital word. This digital word is read by the CPU and is either displayed on the CRT or used in waveform math functions.

Acquisition Cycle

The acquisition theory of operation is presented in a program flowchart. The flowchart applies directly to the infinite persistence mode, which is the simplest flowchart. Variable persistence and average modes have a few added steps to the flowchart. The microprocessor (CPU) controls an acquisition cycle with software instructions. The flowchart is presented from the CPU's point of view. The following steps are software instructions, with added indented comments. The comments will tie the software and hardware theories together.

Start: Program timebase delay

Program A/D input control switches.

The user selects which channels he wants on. The CPU will write to the proper switch enable lines 1-4 (SW1-4) which channels are on and which are off. There are four samplers on the vertical assembly and only one A to D converter on the ADC assembly. All four samplers fire at the same time and the track and hold circuitry will hold the analog values of each channel. Logic on the ADC assembly will search the SW1-4 lines looking for which channels are on. The A to D converter will process, one at a time, only the on channels. The analog signals are converted to digital words which the CPU can display on the CRT. Data from the off channels is not used.

Wait for timebase to settle.

The CPU is waiting for the fine delay DAC (U28) on the horizontal control assembly to settle. The wait time is 50 μs.

Go to Enter1

Loop: Program A/D input control switches

As earlier, this step reprograms the SW1-4 switches on the ADC assembly.

Enter1: Reset GO bit

This is the low go reset (LGORESET) on the horizontal control assembly.

Enable trigger, samplers on.

This step enables various lines to latches U1 and U2 on the horizontal control assembly. The trigger enable line will go low. The sampler high on/low off line (ON/LOFF) will go high at the end of coarse delay. This allows the samplers to sample incoming signals.

Wait for GO bit

The horizontal control assembly uses the GO bit to signal the CPU to process sampled data. The CPU will wait on the GO bit signal before it does any other tasks. If the GO bit is held in a disabled mode, the CPU could hang up in a wait loop. Pressing any front-panel key will exit this wait loop.

Reset GO bit

After the CPU sees the GO bit go high, it resets the GO bit low so the GO bit can signal the CPU when the next sample is taken.

Skip sample

The longest coarse delay word represents 458.752 μs of delay. Longer delays are accomplished by using a software counter. Coarse delay will count down from 458.752 μs to zero. The trigger will fire, and a sample will be taken. Software will check to see if enough delay time has passed. If more delay is needed, then the sample is discarded and the coarse delay counters will start over again.

Disable Trigger.

If the trigger is not disabled, then the timebase would continue to count down and enable the trigger every 458.752 μs. This would cause a new set of data points to be acquired by the samplers and the old set of data points would be discarded. By disabling the trigger on the horizontal control assembly, the timebase will be stopped and data points will not be discarded before the CPU has time to process them.

Read A/D.

The CPU will read the output of the A to D converter for the first channel that is on. Then the A to D converter will process the signal from the next channel that is on. The Track and Hold ICs have a capacitor which holds the sampled data value. The acquisition cycle is interrupt driven with the acquisition interrupt (GO bit) having the highest priority.

Program timebase delay for next acquisition.

This is a repeat of the timebase set-up in the Start routine discussed earlier. While the CPU is processing sampled data it allows enough time for the fine delay DAC to settle within the 50 μs time frame.

If channel 1 is on, then Wait for A to D to finish a conversion.

The CPU is monitoring the status line (STS) from the ADC assembly. Status tells the CPU that an A to D conversion is finished, and it is time to read the A to D's digital output word.

Read A to D converter.

After the CPU reads the A to D converter's output, the low chip select analog to digital converter (LCSAD) will signal the A to D to do a conversion on the next channel which is on.

Plot data if appropriate.

The CPU does not always plot digitized data. It depends on what functions the user selected. The data may be used in waveform math and only the results would be plotted on the CRT. Data may also be acquired specifically to be sent over the HP-IB.

If channel 2 is on, then Wait for A to D to finish a conversion.

The steps for channels 2-4 are identical to the steps for channel 1.

Read A to D converter.

Plot data if appropriate.

If channel 3 is on, then Wait for A to D to finish a conversion.

Read A to D converter.

Plot data if appropriate.

If channel 4 is on, then Wait for A to D to finish a conversion.

Read A to D converter.

Plot data if appropriate.

If the trace is at the end of a sweep, then plot any functions which are on.

It takes the CPU a long time to finish plotting functions. The acquisition hardware may have a block of dead time waiting for the CPU to finish plotting functions.

Go to Loop

Variable Persistence

For variable persistence mode there is an added step before the GO to loop step. This step checks if it is time to erase any of the old data points. The CPU may spend as much time erasing old data points as acquiring new data points.

Average Mode

In the average mode software feedthrough compensation is done. With the samplers turned off, the output of the samplers is digitized through the A to D converters. This first value is the result of sampler feedthrough. Then the samplers are turned on and their outputs are digitized again. This second value is the sum of sampler feedthrough and an actual data point. The first value is subtracted from the second, and the result is the actual digitized point.

ADC Assembly

The following block level theory of operation refers to the analog to digital converter (ADC) assembly block diagram in figure 6B-2.

Track and Hold

The track and low hold (T/LH) signal from the horizontal control assembly enables the track and hold circuitry to detect the first half cycle of the bipolar pulse's amplitude and hold its peak analog value. The bipolar pulse comes from the test set.

Analog Switch Enable

The microprocessor (CPU) enables one or more of the four vertical channels by enabling the proper SW1-4 lines. The combinational logic circuit searches for which channels are on by looking at which of the SW1-4 lines were enabled by the CPU.

Combinational Logic

When enabled by T/LH, the combinational logic circuit searches for the first channel that is turned on. After the first on channel is found, the combinational logic circuit enables the A to D to convert that channel's track and hold output to a 12-bit digital word. After the A to D conversion is finished, the CPU reads the A to D's output. The combinational logic circuit then continues to search for the next channel that is on. This process continues until reset by the T/LH signal, at which time the sequence is started over again.

Analog Switch

The analog switch sends the track and hold outputs, one at a time as directed by the combinational logic circuit, to the 12-bit analog to digital converter (A to D).

Status

The CPU waits until status indicates that the A to D is done with a conversion before reading the A to D's digital lines.

A to D

The A to D converts analog signals to a 12 bit digital word. This digital word is sent through bidirectional bus drivers U37 and U38. The CPU transfers these digital words over the system interface bus (SIB) to the display assembly.

Board ID

The CPU knows the location of each card cage assembly by asking each board for its unique ID number during the initial power-up sequence. Each assembly accessed by the CPU over the SIB has a unique board ID number.

Offset Dac Enable

The offset DAC (digital to analog converter) enable decodes address lines A4-6 into four lines called low chip select offset DAC lines 1-4 (LCSOD1-4). The CPU accesses each offset DAC by enabling one of these four lines.

Offset DACs

There is an offset DAC for each of the four channels. The offset DAC converts 14-bit digital (DAD0-13) words to an analog voltage. The analog voltage is then converted to a current with a range of ± 50 mA. Current drive is used to help reduce cable noise pickup while the offset current is sent through the umbilical cable to the vertical assembly.

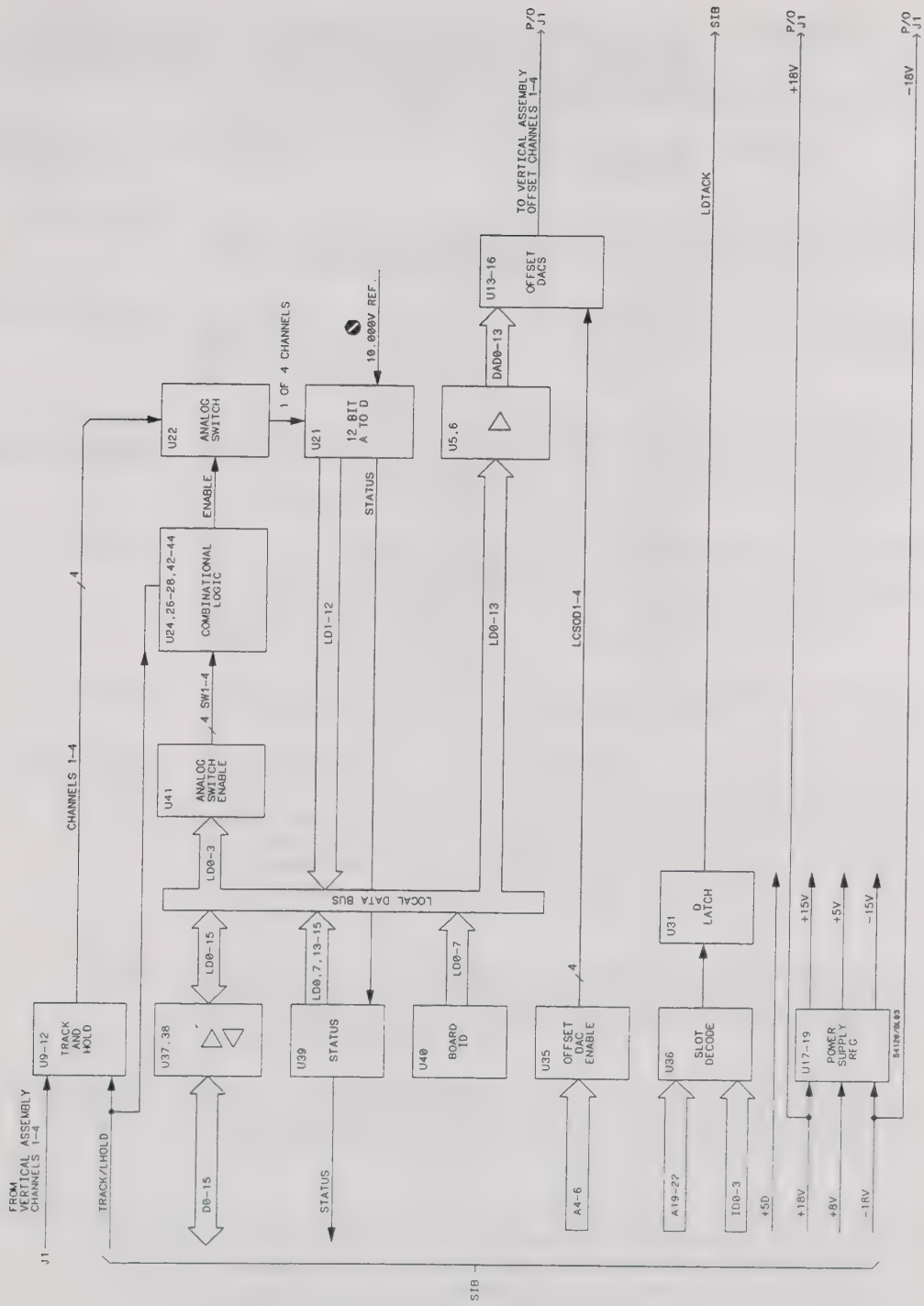

Figure 6B-2. ADC Assembly Block Diagram

Slot Decode The CPU accesses this board by sending out the board's slot ID code over address lines A19-22. U36 is a four bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U36 pin 6 enables other circuitry.

D Latch The D Latch signals the CPU that it has received data with the LDTACK (low data acknowledge) line.

Mnemonics	Definition
A19-22	Address lines 19-22
CCLK1	C Clock 1
CCLK2	C Clock 2
LCSAD	Low Chip Select Analog to Digital converter
DAD0-13	Digital to Analog Data lines 0-13
D0-15	Data lines 0-15
DTRC	Delay To Read Convert
H/LL	High for high bandwidth enable, Low for low bandwidth enable
H/LT	Hold/Low Track
LCSOD1-4	Low Chip Select Offset DAC's 1-4
LD0-15	Local Data lines 0-15
LDTACK	Low Data Acknowledge
LNCH	Low Next Channel
R/LC	High Read/Low Convert
STS	Status
SW1-4	Analog Switch lines 1-4

Horizontal Control Assembly

The following block level theory of operation refers to the horizontal control assembly block diagram in figure 6B-3.

Fine Delay DAC U28 is a 12-bit DAC using LD2-13 to produce a level representing fine delay from 0 to 3.99975 ns. U31 uses LD0 and 1 as sub LSBs to give the DAC more resolution, 1/4 ps steps. This gives the trace a more uniform appearance.

Trigger Level DAC The trigger level DAC is a 12-bit DAC which generates trigger level as selected by the front-panel. Trigger level is used by the trigger hybrid on the horizontal assembly in the four channel test set.

Freerun Clock Generator U30 divides a 2 MHz clock to give a frequency range of 15.3 Hz to 500 kHz, selectable by the front-panel controls. The freerun clock signal drives the TDR generator and trigger hybrid located in the four channel test set. The freerun clock frequency directly affects the output frequency of the TDR generator.

Latches U1 and U2 latch various trigger status signals to the horizontal assembly. These signals are: high frequency reject, trigger enable, TDR on or off, trigger hysteresis, and trigger slope. U11 latches four of the five LSBs of the coarse delay word going to the horizontal assembly. These are timebase bits 1-4 (TB1-4) and correspond to bits 0-3 of the coarse delay word.

Status Status is the only block which transfers data back to the CPU. The GO bit tells the CPU to process sampled data on the ADC assembly.

Coarse Delay Counters U10, 12, and U13 use the 12 most significant bits (MSB) of the 17-bit coarse delay word (LD4-15). When the counters have counted down to zero, a low terminal count signal (LTC2) is generated for the horizontal assembly in the four channel test set. The remaining 5 bits of the coarse delay word are used on the horizontal assembly in the four channel test set. The total length of time for the coarse delay counters is 4 ns to 458.752 μs. Longer delay times are achieved with software counters.

4 ns Bit The fifth LSB of the coarse delay word going to the horizontal assembly is a sub LSB of the coarse delay word. It is TB0 SET and RESET and corresponds to bit 15 of the fine delay word. It is called the 4 ns bit because it is the fourth ns of the coarse delay time interval.

Track And Hold Generator This circuit generates the track and low hold signal for the ADC assembly. Track means to track the output of vertical assembly. Hold means to hold the peak analog value until the A to D converter has time to do a conversion.

GO Bit Generator It generates the GO bit which tells the CPU to process sampled data. When the GO bit is high, analog information is being held by the track and hold circuitry on the ADC assembly. This analog information is waiting to be converted into digital information by the A to D converter on the ADC assembly. When the GO bit goes true (low) it generates an interrupt which tells the CPU a sample has been taken (interrupt 7).

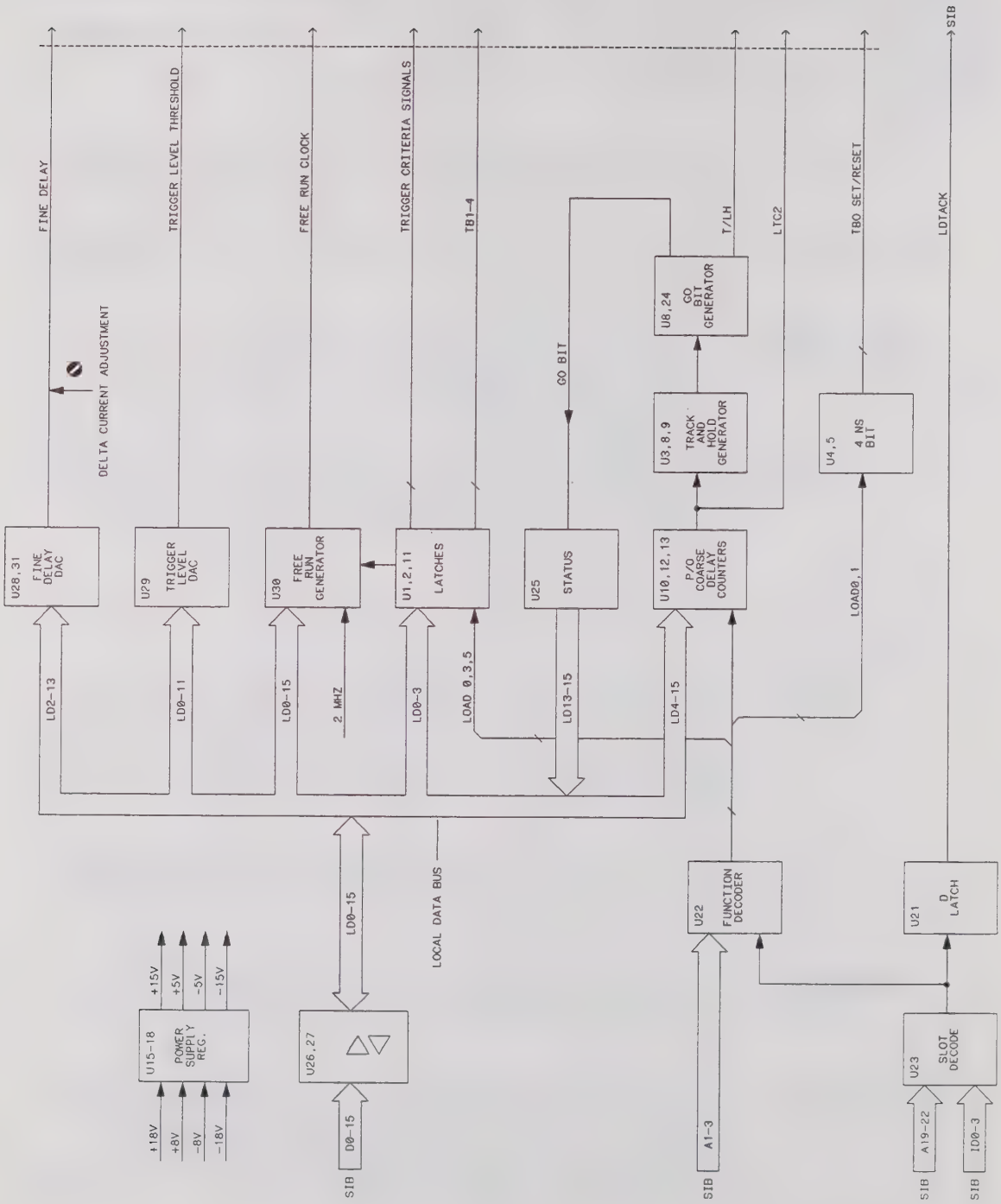

Figure 6B-3. Horizontal Control Assembly Block Diagram

Board ID The microprocessor (CPU) knows the location of each card cage assembly by asking each board for its unique ID number during the initial power-up sequence. Each assembly accessed by the CPU over the SIB has a unique board ID number. The horizontal control assembly generates board ID by pull-up resistors on the LD0-3 data lines, which will be all logic high levels.

Slot Decode The CPU accesses this assembly by sending out the board's slot ID code over address lines A19-22. U23 is a 4-bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U23 pin 6 enables other circuitry.

D Latch The D Latch signals the CPU it has received data with the low data acknowledge (LDTACK) line.

Mnemonics	Definition
A19-22	Address lines 19-22
D0-15	Data lines 0-15
GO	Tells the CPU to process sampled data
H/LT	Hold/Low Track
HF REJECT	Trigger High Frequency Reject
ID0-3	Board ID lines 0-3
LD0-15	Local Data Lines 0-15
LLDS	Low Lower Data Strobe
LDTACK	Low Data Acknowledge
LGO	Low GO
LGORESET	Low GO Reset
LIRQ7	Low Interrupt Request Line 7
LPWRONRST	Low Power On Reset
LSB	Least Significant Bit
LTC2	Low Terminal Count line 2
MSB	Most Significant Bit
Neg/LPOS	Trigger slope select high for Negative/low for Positive
OFF/LON	Turns TDR generator Off and On
R/LW	Read/Low Write
SELECT	Board Select
LENABLE/RESET	Trigger Low Enable/Reset
T/LH	Track/Low Hold
Sampler ON/LOFF	Turns Sampler ON and Off
SIB	System Interface Bus

I/O Assembly

The following block level theory applies to figure 6B-4. The I/O Assembly serves two major purposes. First, it provides instrument interface to the keyboard and HP-IB by two ribbon cables. Second, it provides several system functions, all of which are described below. In addition the I/O contains passive pull-up resistors for the data, address, and control lines for the System Interface Bus, (SIB).

Slot Decode The CPU accesses this board by sending out the board's slot ID code over address lines A19-A22. U45 is a 4-bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U45 pin 6 will output a pulse which enables other circuitry.

LDTACK Generator U35 generates LDTACK, which is sent back to the CPU indicating data was received. This signal also resets the bus error timer.

Bus Error Timer Under normal operation U18 should be reset by LDTACK before a time constant set by R19 and C40 times out. If U18 is not reset, it will generate LBUSERR. This keeps the CPU from getting hung up in an instruction cycle. This could happen if any addressed board does not generate LDTACK or if the CPU tries to access a nonexistent board.

Board ID One side of U42 is hardwired to represent the board ID number. When the CPU asks for board type, U42 places a board ID number on the local data bus.

HP-IB U1 interprets HP-IB commands and controls the direction of data flow from an external controller to the local data bus. One side of U1, LD0-7, connects to the local data bus. The other side of U1 connects to two bidirectional data transceivers, U4 for data and U5 for control commands. Because HP-IB addressing is accomplished by software, no address lines are carried on the ribbon cable.

Function Decoder Function decoder U10 decodes address lines A12-A14 to enable, keyboard controller, RPG counter, HP-IB controller, board type, and power supply status.

Keyboard Controller Keyboard controller U21 sees a key closure and interrupts the CPU by the IRQ4 line. U21 detects which key was pressed by scanning column lines with pulses and sensing rows for a return path. When U21 is enabled, it converts key closure scan data to parallel data and places this data on the local data bus.

Dynamic Ram The I/O assembly provides 256k words of additional CPU memory used for waveform storage and other purposes. The memory is an array of sixteen 64k by 4-bit dynamic RAMs. Dynamic RAM is addressed in rows and columns with low row address strobe (LRAS1-4) and low column address strobes (LCAS1-8). Dynamic memory must be refreshed at regular intervals to maintain memory. This is accomplished with refresh counters U19-31. From the CPU's perspective the dynamic RAM is a slot by itself, irrespective of the slot for the I/O assembly. The other assemblies are identified by their slot ID code. U51 is a 4-bit comparator which compares address lines A19-22 with code 10 decimal which is hardwired on the other comparator input. The CPU sees the dynamic RAM at slot 10 no matter which slot the I/O board is in.

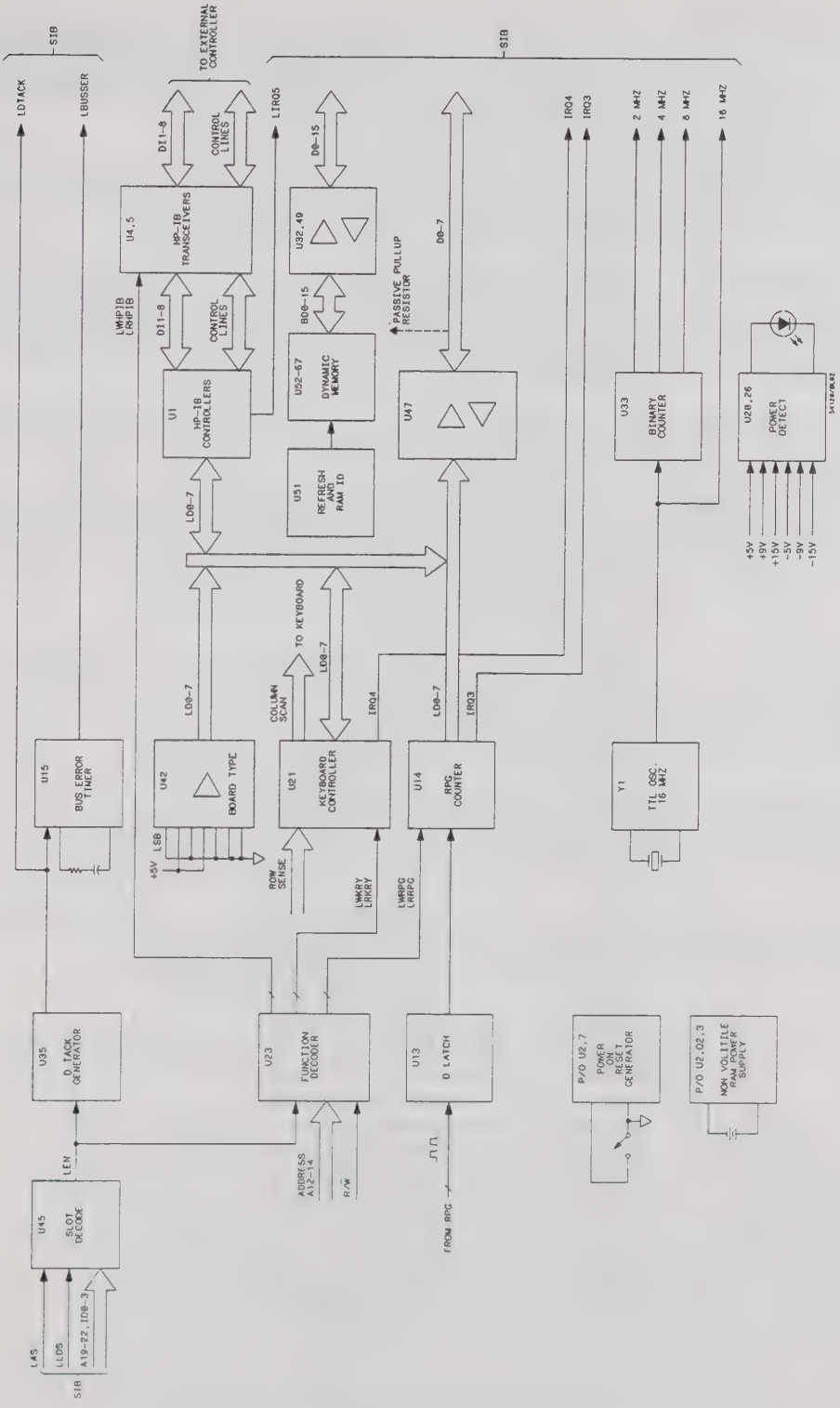

Figure 6B-4. I/O Assembly Block Diagram

RPG Counter

The RPG outputs two out-of-phase pulses. Direction of rotation is determined by the difference in phase angle between both pulses. The pulse frequency is a function of rotation speed and this tells the microprocessor (CPU) what size of incremental steps to take. Part of U13 detects RPG activity and interrupts the CPU by the IRQ3 line.

TTL Oscillator

The TTL oscillator is a crystal controlled 16 MHz oscillator. A binary counter divides this into 8 MHz, 4 MHz and 2 MHz. All four signals are placed on the system interface bus for use by other assemblies.

Power-on Reset

The power-on reset circuit provides a glitch-free pulse shortly after power up and power down. This sets many devices to a known state and prevents the CPU from taking damaging action during power up. This also provides a means to reset the system with a push button, without powering down the instrument.

Power Detect

The power detect circuit samples all six supply voltages. If one or more fails, the LED on top of the I/O assembly will not illuminate.

Non-volatile Ram Power Supply

A battery provides the necessary power for RAM on the CPU assembly to retain basic setup information and system configuration for several years. The circuit also provides for smooth transfer of power from the battery to the power supplies after initial power up.

Mnemonics	Definition
DI1-8	HP-IB Data lines 1-8
D0-7	SIB Data lines 0-7
DS	Data Strobe
IDO-3	Board ID lines 0-3
LIRQ1-7	Low Interrupt Request lines 1-7
LA1-3	Local Address lines 1-3
LAS	Low Address Strobe
LCAS1-8	Low Column Address Strobe lines 1-8
LDTACK	Low Data Acknowledge
LD0-7	Local Data lines 0-7
LEN	Low Enable
LLDS	Low Lower Data Strobe
LRAS1-4	Low Row Address Strobe lines 1-4
LRHPIB	Low Read HP-IB
LRKEY	Low Read Keyboard
LRPWR	Low Read Power
LRRPG	Low Read RPG
LSB	Least Significant Bit
LSTROBE	Low Strobe
LUDS	Low Upper Data Strobe
LWHPIB	Low Write HP-IB
LWKEY	Low Write Keyboard
LWRPG	Low Write RPG
R/LW	Read Low Write
RPG	Rotary Pulse Generator
SIB	System Interface Bus

Microprocessor Assembly

The following theory applies to figure 6B-5. The microprocessor (CPU) has two major functions, data acquisition and I/O interfacing. It starts an acquisition cycle by resetting the GO bit to a logic low level. The CPU then waits for the GO bit to go high again. The GO bit going high tells the CPU to process sampled data. I/O interfacing involves updating display information, interpreting key closure data, RPG data, and HP-IB commands. In remote mode the CPU takes commands from an external controller.

CTC The counter timer chip (CTC) contains three counters. The CPU programs and reads each counter over LD0-7 lines. Each counter has an output which is used as an interrupt to the CPU. All three counter outputs are ORed through U35 and U42. The result is ORed through U40 with LIRQ6 from the SIB and applied to the system interrupt latch.

System Interrupt Latch The system interrupt latch allows the CPU to mask off any or all interrupt lines. The CPU sends data to U1 on LD0-7 lines. For normal operation all outputs of U1 are normally a zero, and all incoming SIB interrupt lines are normally a one. When an interrupt occurs on the SIB that interrupt line will be a zero, the corresponding output of U17 or U18 will also be a zero. The CPU can mask off any interrupt lines by simply writing a one to U17 or U18 through U1. This will guarantee that corresponding output levels of U17 or U18 will also be a one regardless of what the SIB interrupt lines are doing.

Interrupt Priority Encoder This circuit encodes all seven incoming interrupt lines into three lines for the CPU. If more than one interrupt occurs at the same time, U34 will prioritize them so the interrupt with the highest priority will be processed first. When an interrupt occurs, the system is vectored to a predetermined software location.

Bus Arbitration This board contains circuitry so it will operate in a multiprocessor system. Since only one CPU is used, the bus request and bus grant signals are tied to the proper logic levels to ensure this board will have control over the SIB when required.

Bus Buffers They enhance the drive capabilities of the CPU. When enabled, they connect the CPU with the correct bus, these are: U48 and U49 for SIB data bus U45, U46 and U47 for SIB address bus U4 and U21 for local data bus U5, U6, U22 and U23 for local address bus

Decoders U36 decodes PA16-18 to enable ROM pairs 0-7. U19 decodes PA14-16 to enable RAM pairs 0 and 1, interrupt latch, and counter timer chip.

CPU This chip is a Motorola 68000 microprocessor running at 8 MHz. Main characteristics are, 16-bit data bus, 23-bit address bus, and 3 interrupt lines. At initial power up condition, power on reset (POR) insures the CPU will start-up in a known condition. The CPU will then run several routines, some of which are: determine which board type is in which slot, system self-diagnostics, and setup display information. The CPU will now respond to system interrupts, HP-IB, keyboard, or RPG. To the CPU all boards connected to the SIB look like memory locations. When A23 is a logic high level, the CPU is accessing system memory over the SIB. When A23 is a zero, then the CPU is accessing local processor board memory locations. After the CPU sends data over the SIB, LDTACK returns from the addressed board and signals the CPU the information was received. LDTACK also goes to the I/O board and resets a buserror timer. If the buserror timer is not reset, BUSERR is sent to the CPU. The CPU will display a SOFTWARE ERROR message on the CRT.

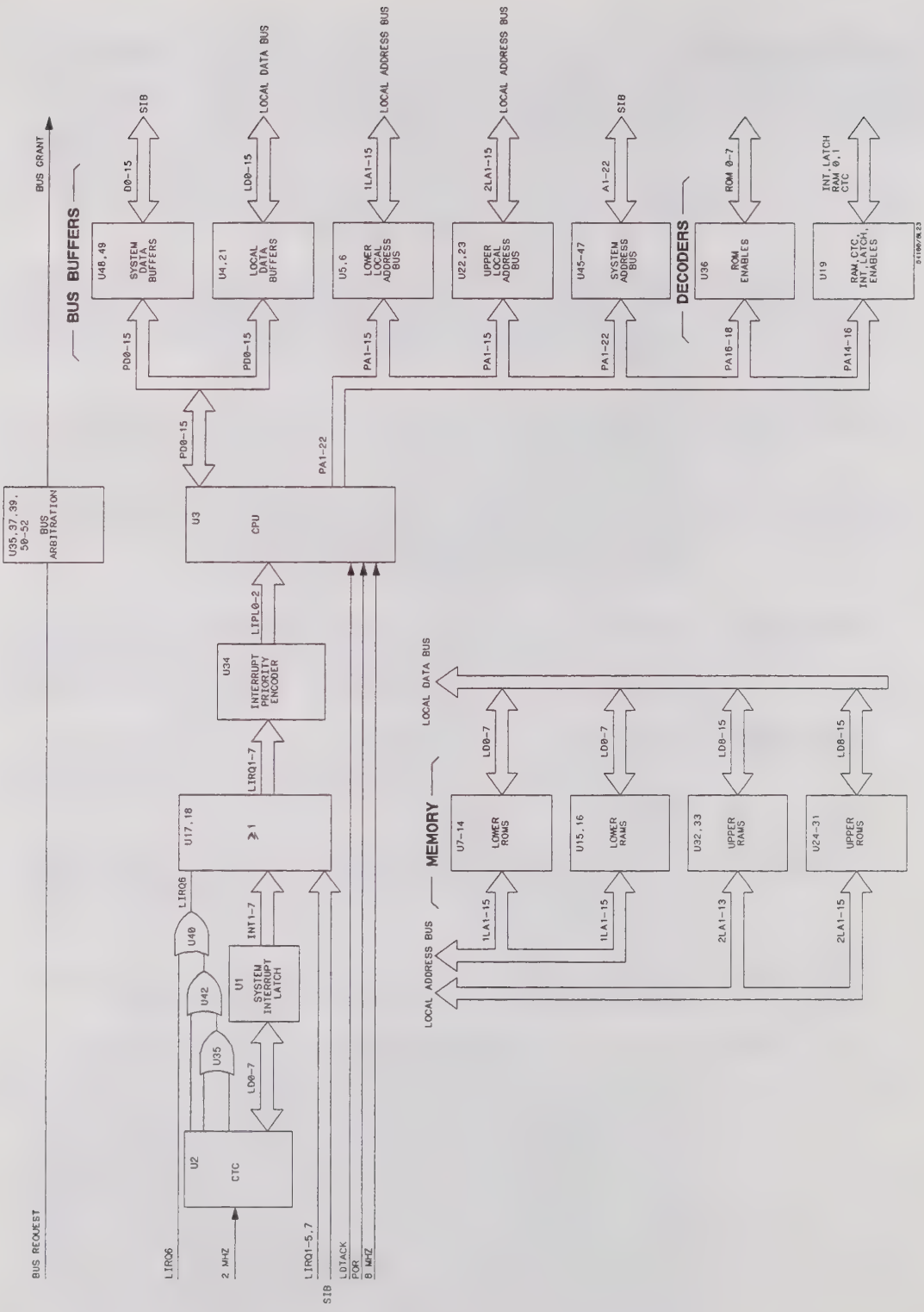

Figure 6B-5. Microprocessor Assembly Block Diagram

Memory

The ROMs and RAMs have 8-bit data lines. The 16-bit words are divided into a lower portion LD0-7, and an upper portion LD8-15. All the ROMs or RAMs are read in pairs. Software instructions for the CPU are contained in ROM memory. There is space for eight ROM pairs, but not all of the space is used. Non-volatile battery backed-up RAM memory contains stack registers, status registers, scratch pad memory, and soft-cal information.

Mnemonics	Definition
CPU	Central Processing Unit
CTC	Counter Timer Chip
LD0-15	Local Data lines 0-15
LDTACK	Low Data Acknowledge
LIRQ1-7	Low Interrupt Request lines 1-7
PA1-22	Microprocessor Address lines 1-22
PD0-15	Microprocessor Data lines 0-15
POR	Power On Reset
SIB	System Interface Bus
1LA1-15	Lower Local Address lines 1-15
2LA1-15	Upper Local Address lines 1-15

Color Display Assembly

This theory refers to figure 6B-6. The board is the interface between the host microprocessor and color monitor. It has graphics memory, timing generator, character generator, prioritizing circuitry, color map, and color output DACs.

Function Decoder

It decodes HA13-15 to enable various board functions, CRTC for the CRT controller, ID for board type, COLOR MAP for the color map and output DACs, priority for RAM.

D Latch

This circuit outputs LDTACK over the SIB indicating data was received from the CPU.

Slot Decode

The CPU accesses this board by sending out the board's slot ID code over address lines A19-22. U141 is a four bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U141 pin 6 enables other circuitry.

CRT Controller

The CRT controller controls several board functions, timing signals for the color monitor, blanking, horizontal drive, vertical drive, and character control functions.

Character RAM

Characters are stored in RAM as a 16-bit word, eight bits for an ASCII word and eight bits for character attributes.

Bit Number	Function	Bit Number	Function
TD0-6	ASCII character	TD10	Underline
TD7	Not used	TD11-14	Color
TD8	Inverse video	TD15	Priority bit
TD9	Blink		

Character ROM

It functions as a character generator by decoding ASCII data, TD0-7, from character RAMs and sending it through character shift registers to the encode circuit.

Character Shift Registers

They are parallel loaded with character data and output character video in serial format.

Attribute Logic

It converts TD8-15 to attributes, four bits for color and four bits for other attributes. To define these bits, refer to the table under Character RAM heading discussed earlier.

Dual Port Arbiter

The dual port arbiter outputs addresses from either the host CPU or from an outside controller and places graphics on the CRT.

Display Address Counters

These are 4-bit counters which generate graphic address lines GA0-13.

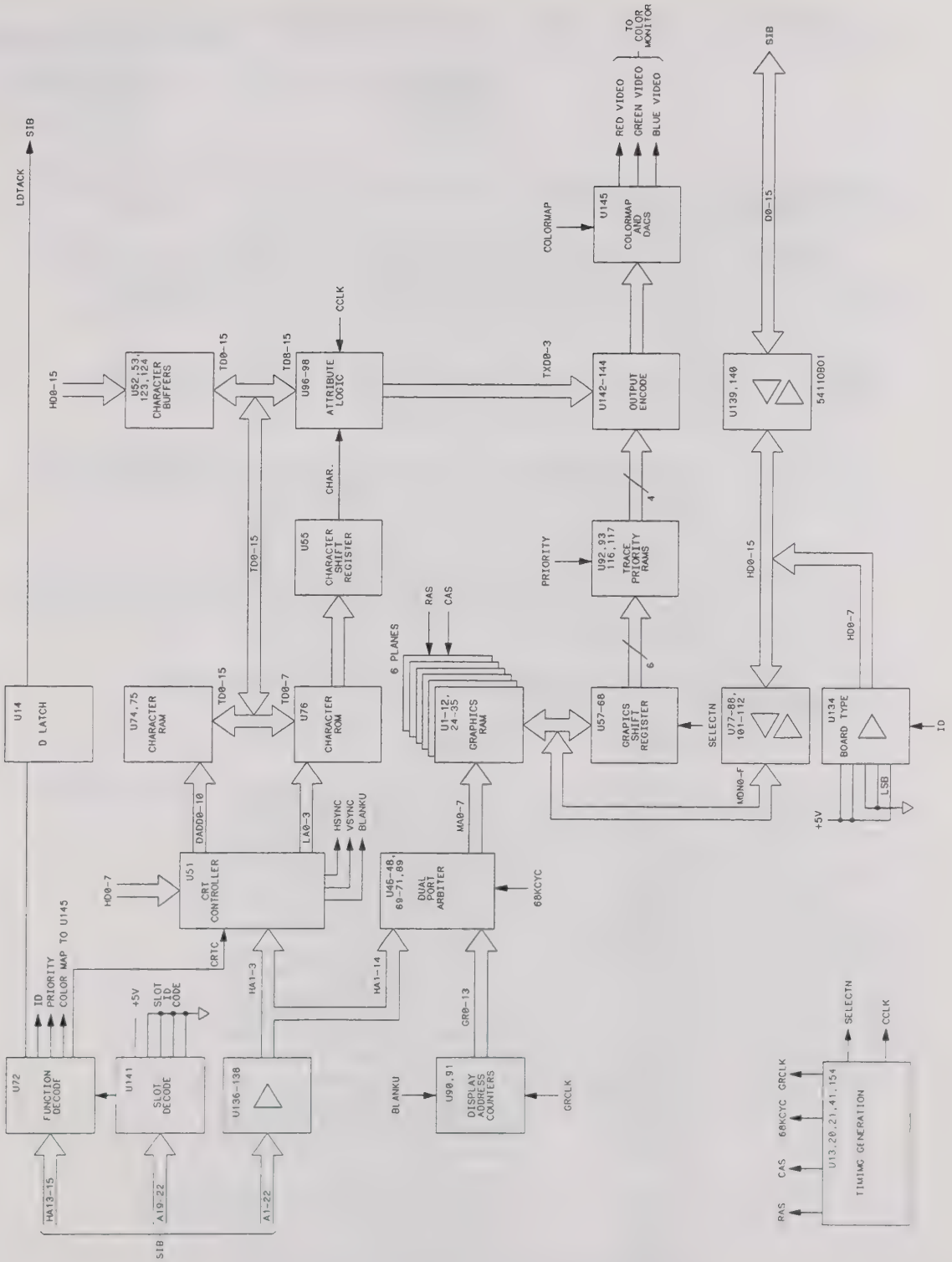

Figure 6B-6. Color Display Assembly Block Diagram

Graphics RAM There are six planes of dynamic memory where graphics data is stored.

Plane	Information	Plane	Information
0	Graticules	3	Channel 2
1	Stored Traces	4	Channel 3
2	Channel 1	5	Channel 4

Graphics Shift Registers This circuit is parallel loaded with graphics data and it serially outputs graphics video.

Trace Priority Encode This is a high speed RAM whose function is to map outputs from the graphics planes into unique address locations for the color map. It also provides arbitration when more than one plane tries to illuminate the same pixel location. Plane 0 has the lowest priority while the other places have equal priority.

Output Encode This circuit uses either graphics data or character and attribute data to generate addresses for the color map.

Color Map And Output DAC The color map consists of three color RAMs which convert the encoded addresses to a digital value. There is one output DAC for each color RAM. The output DACs convert this digital value to red, green, or blue levels for the color monitor.

Board ID When board type is requested by the CPU, this board will respond with 25 over the LD0-7 lines. LD0, 3 and 4 will be pulled high through U134, LD1 and LD2 will be pulled low through U134. LD0 is the least significant bit so adding LD0, 3 and 4 equals 25.

Timing Generation Timing generation controls timing functions for the display board.

Mnemonics	Definition
A1-22	SIB Address lines 1-22
CAS 0-5	Column Address Strobe lines 0-5
CCLK	Character Clock
D0-15	SIB Data lines 0-15
DADD0-13	Display Address lines 0-13
DP0-5	Display Planes 0-5
GA0-13	Graphics Address lines 0-13
GRCLK	Graphics Clock
HA1-22	Local Address lines 1-22
HD0-15	Local Data lines 0-15
HIP21	High Priority bit 21 (Disables Graphics)
HSYNC	Horizontal Sync
LDS	Lower Data Strobe
LDTACK	Low Data Acknowledge
MA0-7	Memory Address lines 0-7
MD0-15	Memory Data lines 0-15
RAS 0-5	Row Address Strobe lines 0-5
SIB	System Interface Bus
TD0-15	Text and Attribute lines to character ROM
TXD0-3	Text and Attribute lines to encode circuitry
UDS	Upper Data Strobe
VSYNC	Vertical Sync

Power Supply Assemblies

This theory refers to figure 6B-7.

Primary Supply

The primary supply rectifies and filters the input ac voltage. When the voltage select switch is in the 230 V position, the ac is bridge rectified and filtered to yield approximately 300 V dc and 120 V dc. The 120 V dc is generated by an isolating switching regulator, and is used to power the color monitor. The 300V dc is used for the digital and analog supplies. The input voltage is doubled in the 115 V position to yield the same dc voltages. The primary board has surge protection circuitry that protects against ac line voltage transients and current surges. Over-voltage crowbar devices trip the circuit breaker for sustained input over-voltage conditions. The pulse width modulator (PWM) circuitry is powered by a bleeder resistor on one of the bulk storage capacitors. The main EMI (electromagnetic interference) filter is located in a dc current path to reduce component size and to increase the filter's effectiveness.

Digital Supply

The digital power supply is a dc to dc converter which converts 300 V dc to +5 V and -5.2 V dc. The Pulse Width Modulator (PWM) Is used to achieve voltage and current regulation by changing the PWM's turn-on time. It has an operating frequency of 68 kHz. The Power Stage performs the actual conversion of 300 V dc to +5 V and -5.2 V dc. Digital and primary ground planes are kept isolated through transformer T2. The Optical Isolators are used to isolate the primary and digital ground planes. Voltage and current feedback control is sent through U2 to control the duty cycle of the PWM. Power supply shutdown is sent by U3. The Loop Control and Supervisory circuitry detects when excessive output voltage occurs. It sets a latch in the PWM which can only be reset by cycling the circuit breaker off for 60 seconds, or an instantaneous reset by cycling the front panel power switch. It also senses the current and activates foldback current limiting for excessive current loading.

Analog Supply

The analog power supply is a dc-to-dc converter which converts 300 V dc to ±18 Vdc and ±8 Vdc. The Pulse Width Modulator (PWM) is used to achieve voltage and current regulation by changing the PWM's turn on time. It has an operating frequency of 68 kHz. The Power Stage performs the actual conversion of 300 V dc to ±18 Vdc and ±8 Vdc. There is a fan drive output that increases fan speed with ambient temperature. Analog and primary ground planes are kept isolated through transformer T2. The Optical Isolators are used to isolate the primary and analog ground planes. Voltage and current feedback control is sent through U2, to control the duty cycle of the PWM. Power supply shutdown is sent through U3. The Loop Control and Supervisory circuitry detects when excessive over-voltage occurs. It sets a latch in the PWM which can only be reset instantaneously by cycling the front panel power switch to standby and then to on, or by turning the circuit breaker to the off position for 60 seconds. +18 V is regulated and the other outputs are semi-regulated outputs which follow the +18 V. Each output is current-limited. The -8 V output has foldback current limiting.

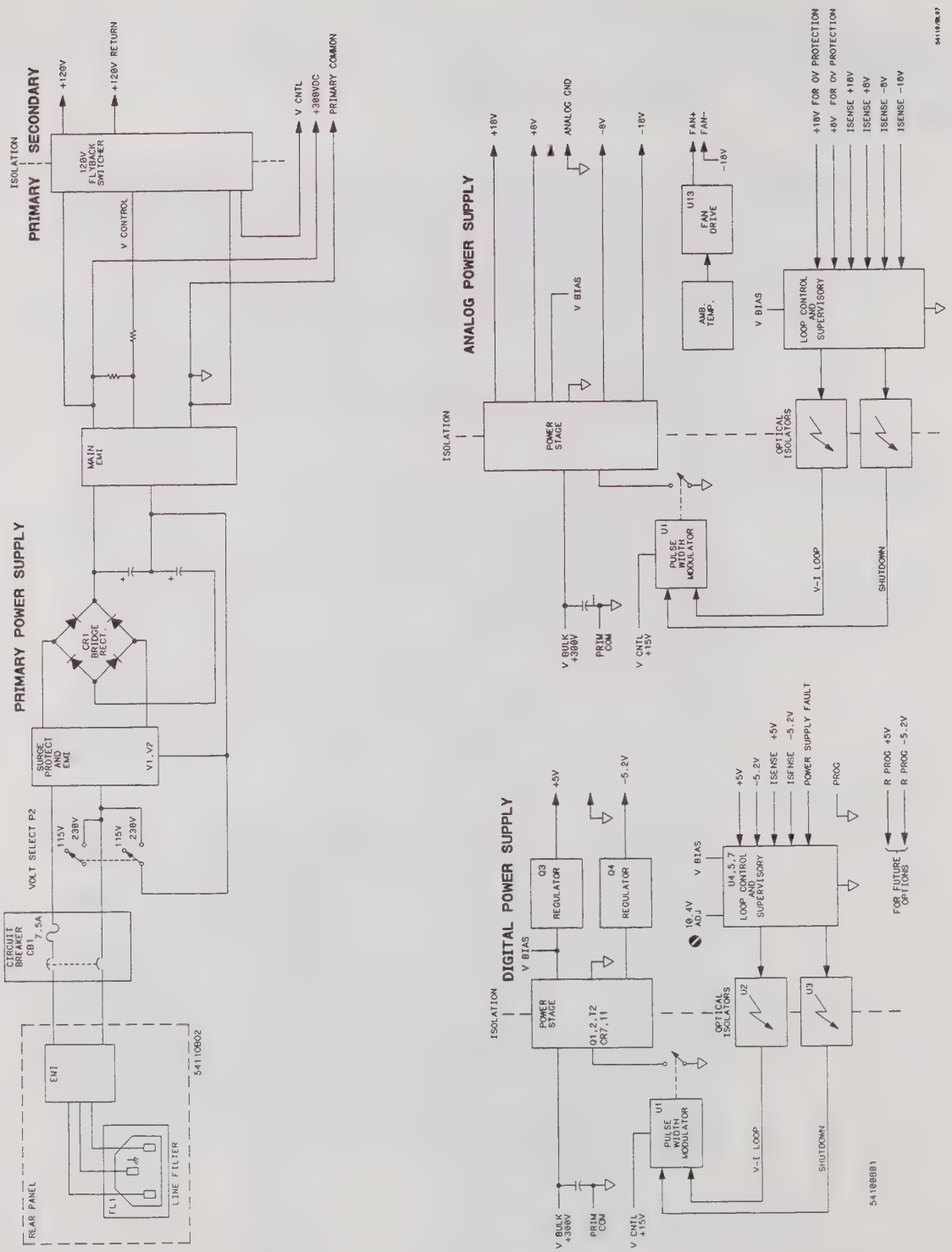

Figure 6B-7. Power Supply Assembly Block Diagrams

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Service Menus 6C

Introduction

This section describes the service menus and keys that are available for calibration, troubleshooting, and CRT display alignment. A basic understanding of these will be helpful in troubleshooting failures. However, Self-Test and Troubleshooting is covered specifically in Section 6D.

Service Menus

The service menus are part of the Utility menu, in the second level of the menu softkeys. Pressing the **Utility** key will display five other function keys: Cal Menu, Test Menu, CRT Setup, Color Cal Menu, HP-IB Menu.

CAL Menu

The Cal Menu is used to calibrate the instrument. The calibration factors are stored in non-volatile memory. Use of this menu is covered in the "Front Panel Operation Reference". Basic functions of the Cal menus are covered in this section.

Test Menu

The Test Menu provides several functions used to set up and run internal diagnostics test and view the results. Use of these functions is covered briefly in this section and comprehensively in the Self-Tests/Troubleshooting, section 6D.

CRT Setup

The CRT Setup Menu provides several functions that provide confidence testing as well as test patterns for adjusting the Color CRT Module. These functions are discussed in this section.

Color Cal Menu

The Color Cal Menu provides functions used to set the characteristics of the colors displayed. These characteristics include hue, saturation, and luminosity. This menu is covered in detail in the "Front Panel Operation Reference.

HP-IB Menu

The HP-IB Menu provides keys that are used to set the HP-IB attributes. These attributes are address number, Talk/Listen, and EOI. This menu is discussed in detail in the "Front Panel Operation Reference".

One-key Power Up

A one-key power up is performed to return the instrument to a known (default) front panel condition. This is done as follows:

1. Set the front panel POWER switch to STBY.
2. Press and hold any front panel key.
3. Turn front panel POWER switch to ON.
4. Release key when display shows "Powerup Self Test Passed!" or "Failed".

Two-key Power Up

A two-key power up is a basic reset of the entire operating system of the HP 54120B. All volatile and non-volatile RAM is cleared. As a result, all calibration factors are purged, front panel setups are erased, and the instrument must be recalibrated.

Caution

Using the two-key powerup will leave the instrument in an uncalibrated state. Effort needed for recalibration should be considered before using this mode to reset the instrument.

1. Set the front panel POWER switch to STBY.
2. Press and hold the top and bottom function keys.
3. Turn front panel POWER switch to ON.
4. Release keys when display shows "Powerup Self Test Passed!" or "Failed".

Cal Menu

Channel Vertical Cal

Channel Vertical Cal sets software calibration factors to correct for sampler gain and offset errors. The calibration is run by pressing the appropriate menu and function keys. All front panel inputs must be disconnected from the instrument. Refer to the specifications under general information in the test set service manual for a recommended cal interval.

Channel Skew Cals

The channel skew calibration is a user calibration which minimizes the delays between channels and also the external trigger input. If this calibration is performed in a calibration facility, use cables and signals similar to what the user will use with the oscilloscope.

Channel Atten Cals

This key only appears when the HP 54122A Four Channel Test Set is connected to the HP 54120B. The calibration measures the actual attenuation of the step attenuators and performs a software compensation. After a two-key power up, this calibration should be performed to ensure the correct values are stored. A very accurate dc source is required.

Test Menu

Five sub-menus are available when the Test Menu is selected. The menus allow the user to access and run internal diagnostics and view the results. In addition, the position of each card cage printed circuit board can be read and displayed, and the firmware revision date is displayed. Use of the test menus is covered in depth in section 6D, Troubleshooting.

Note

The top key toggles between REPEAT LOOP and RUN FROM LOOP. These keys in conjunction with Loop Number = [0-43] and the Start/Stop Test key will execute internal self-test diagnostic routines. All input signals must be disconnected from the instrument for these tests.

Repeat Loop

Selecting this mode will continuously execute the Loop number entered at RUN FROM LOOP. Pressing **Start Test** will start execution and the loop will continuously run until the **Stop Test** key is pressed. Pressing **Display Errors** will show how many times the loop was executed and the number of times the loop failed.

There are a number of loops that will blank or over-write the Stop Test key display on the CRT. However, the test can still be terminated by pressing the third function key from the top.

Run From Loop

Selecting this mode will start execution from the loop entered and will proceed to execute all higher numbered loops. Upon reaching the last test, the cycle will be repeated.

If any test should fail, the instrument will change from RUN FROM LOOP to REPEAT LOOP and will repeatedly execute the loop that failed until the **Stop Test** key is pressed.

Extended Tests

When this key is chosen there are 13 internal instrument tests that may be selected by entering the test number with the entry devices. These tests are numbered 0 through 12. All input signals must be disconnected from the instrument for these tests. Many of the extended tests are useful only at the factory. Those that are of use to field service personnel are covered in section 6D, troubleshooting.

Start/Stop Test

This key is used to initiate any test where a test number is entered by one of the entry devices. Once the test number is entered, pressing **Start Test** initiates the test and the key toggles to Stop Test. Pressing **Stop Test** stops the test in progress and the key toggles back to Start Test.

There are a number of tests that will blank or over-write the Stop Test key display on the CRT. However, the test can still be terminated by pressing the third function key from the top.

Display Errors

Pressing the **Display Errors** key will display the number of any loops which failed. The tests which test for loop failures are: Powerup self test, EXTENDED tests, REPEAT and RUN FROM LOOP tests, and HP-IB commanded self test. This display shows the current loop or last loop executed, the number of times the loop was executed, and the number of times that it failed. The bottom portion of the display shows all loops that failed starting with the first loop failure. These are cummulative failures and they are erased only on power up or I/O assembly reset.

The four STATUS X = XXXXX lines in the Display Errors field are primarily for factory use. Any field usable information in this part of the display is covered in section 6D, troubleshooting. To return to the Test Menu, press **Exit Display** key.

Display Configuration

Most of the assemblies used in the mainframe have circuitry that allows them to be interrogated directly by the microprocessor. The exception being the microprocessor assembly. The mainframe card cage has 9 slots, but only four assemblies are in the card cage. When the **Display Configuration** key is pressed the resulting display shows the location of the card cage assemblies, except the microprocessor. The display assembly is shown as being in slot 14, this is not part of the card cage but is on the instrument's bottom side. The firmware revision date is also displayed. To return to the Test Menu, press **Exit Display** key.

CRT Setup Menu

When CRT Setup Menu is selected, four keys are displayed that allow access to CRT setup displays. The keys available are, from top to bottom, Confidence Test, Pattern Off, Light Output Off, Color Purity Off, and at the bottom, Exit CRT Setup Menu.

Even though some of the patterns overwrite the key display, the functions can be selected. The bottom key can be pressed at any time to exit the CRT Setup Menu.

Confidence Test

When this function is selected, the confidence test pattern is displayed. The pattern consists of three parts. At the top is a complete character set, in the center is a group of seven color blocks, and at the bottom a seven block grey-scale.

The top four lines of the character set display include the complete character set. The bottom line displays three sets of numerals. The first set is displayed in inverse video, the second set, and the third set is normal video and underlined.

The seven color blocks displayed at the center are, from left to right; beige, grey, red, yellow, green, amber, and cyan.

Note

Since color perception is subjective, any slight variation in colors from what is described here should be disregarded.

At the bottom of the CRT a seven block grey-scale is displayed, with increasing luminosity from left to right. This grey-scale display is used if Color CRT Module adjustments are necessary.

Pattern

These patterns are used when Color CRT Module adjustments are necessary. When CRT Setup Menu is selected, this key is initially Pattern Off.

Pressing **Pattern Off** once will display a white cross-hatch pattern over the entire CRT and the Pattern Off key changes to Pattern White. Inside the cross-hatch pattern there are dots at the center, corners, and at the 12, 3, 6 and 9 o'clock positions. Additionally, there are test matrices in the center and corners.

Pressing **Pattern White** key changes the pattern color to red and the key label changes to "Pattern Red". Repeatedly pressing this key will change the color of the pattern to green then blue. The name of the Pattern key is the color displayed.

Pressing **Pattern Blue** key changes the display to the white cross- hatch pattern on the top half of the CRT and white with a dark cross- hatch on the bottom. The key then changes to Pattern HV Reg. This test is used primarily by the factory, however, it may indicate the need for service if there are severe high voltage problems.

Pressing **Pattern HV Reg** changes the display to a solid white screen with dark cross hatch lines. The key changes to Pattern I White. Successive pressing of this key changes the color to red, green and then blue, the name of the Pattern key is again the color of the display.

Pressing **Pattern I Blue** changes the display to a white cross-hatch pattern with the inside flashing between solid white and cross-hatch. The key changes to Pattern Bounce. This test is primarily used by the factory, however, it may indicate the need for service if there are severe high voltage problems.

Pressing **Pattern Bounce** exits this set of tests and returns the CRT Setup Menu.

Light Output

These displays are used by the factory.

Pressing **Light Output White** displays a horizontal band of white half the height of the display. The key display is not overwritten. Repeatedly pressing this key will change the color of this band to red, green, blue and then a grey-scale. Each time the key is pressed it also changes to the appropriate description.

Pressing **Light Output Grey-Scale** exits this set of tests and returns the CRT Setup Menu.

Color Purity

Pressing **Color Purity Off** displays a full white raster. Repeatedly pressing this key changes the color of the raster to red, green and then blue. At each color display the name of the key changes to the appropriate description. These displays are used when Color CRT Module adjustments are necessary.

Pressing **Color Purity Blue** exits this set of tests and returns the CRT Setup Menu.

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Troubleshooting 6D

Introduction

This section contains troubleshooting information for fault location to the PC assembly level for the HP 54120B. Reading sections 6B, theory of operation, and 6C, service menu keys, will help in understanding this section.

Safety Considerations

The following warnings and cautions must be followed for your protection and to avoid damage to the equipment.

Warning

This instrument is equipped with a standby switch on the front panel that DOES NOT de-energize the power supply. To avoid shock hazards capable of causing injury or death, the main power switch on the rear panel must be used to de-energize the instrument or the power cable must be disconnected when the instrument must be de-energized.

Warning

Maintenance described in this section is performed with power supplied to the instrument and with protective covers removed. Maintenance should be performed only by trained service personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed. Read the Safety Summary in the front of this manual.

Caution

Do not remove or replace any of the circuit board assemblies in this instrument unless instrument power is removed. The assemblies contain components which may be damaged if they are removed or replaced when instrument power is applied.

Recommended Test Equipment

Equipment recommended for service is listed in table 1-1. Any equipment that satisfies the critical specifications stated in the table may be substituted.

Logic Family Used

The logic level used on the HP 54120B Mainframe is TTL. TTL ranges from approximately 0 V to 5 V.

Diagnostic Overview

Start all diagnostics by first verifing the failure mode. Then follow the main troubleshooting flowchart, figure 6D-1, to determine if the failure is in the mainframe or data acquisition system. The flowchart covers the mainframe system troubleshooting (CPU, I/O, power supplies, keyboards and display system). Sometimes this section will refer to particular paragraphs in the four channel test set service manual. For data acquisition failures refer to the four channel test set service manual for these troubleshooting procedures.

One Key-down Power Up

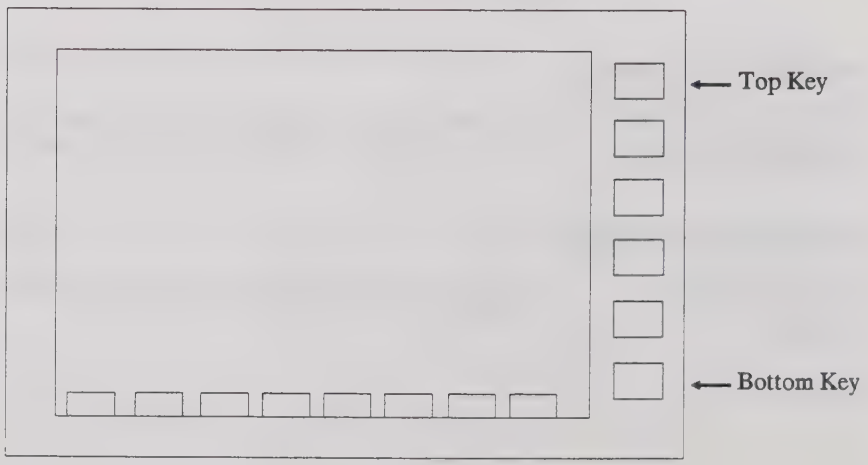
A one key-down power up places the instrument in a default condition. This default condition is identical to sending an HP-IB "RESET" over the bus. This allows users a known starting point to begin their test procedures from. Hold down any key while cycling the oscilloscope's power off and on. Continue to hold the key down until graticules are displayed on the screen.

Two Key-down Power Up

A two key-down power up sets up the instrument identical to a one key-down power up. It also clears all the RAM memory locations, resets all digital storage devices, clears vertical software calibration factors, and clears the channel to channel skew factors (clears channel attenuation cal factors in HP 54122T).

1. Turn oscilloscope's power switch to STBY.
2. Hold down the top and bottom function keys on the screen's rightside.
3. Turn oscilloscope's power switch to ON and continue holding function keys down until graticule display is on screen.
4. Ignore "Front Panel Cals Lost" warnings on top of screen, CALs will be performed later.

Keys to Hold down for two key-down powerup



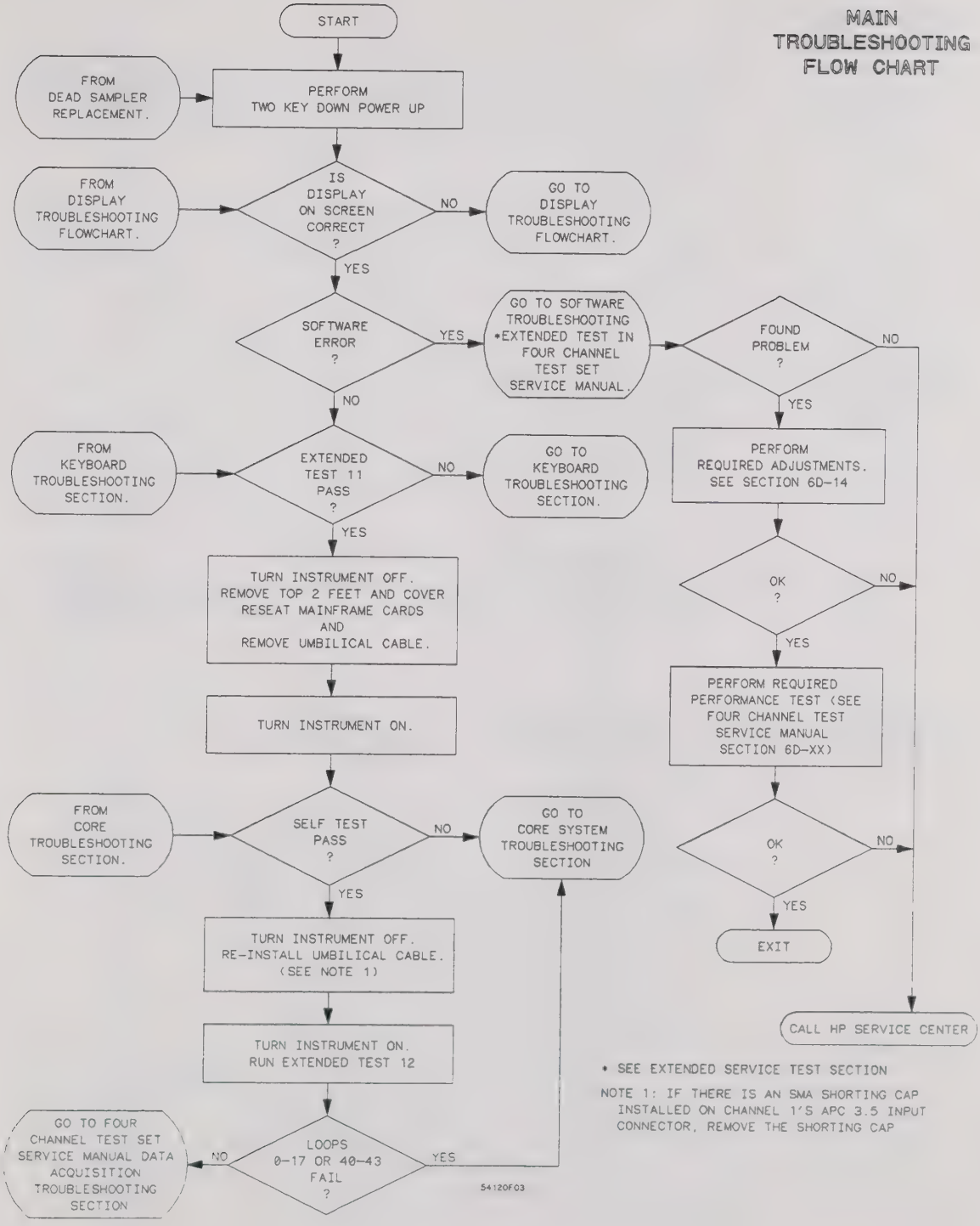


Figure 6D-1. Main Troubleshooting Flowchart

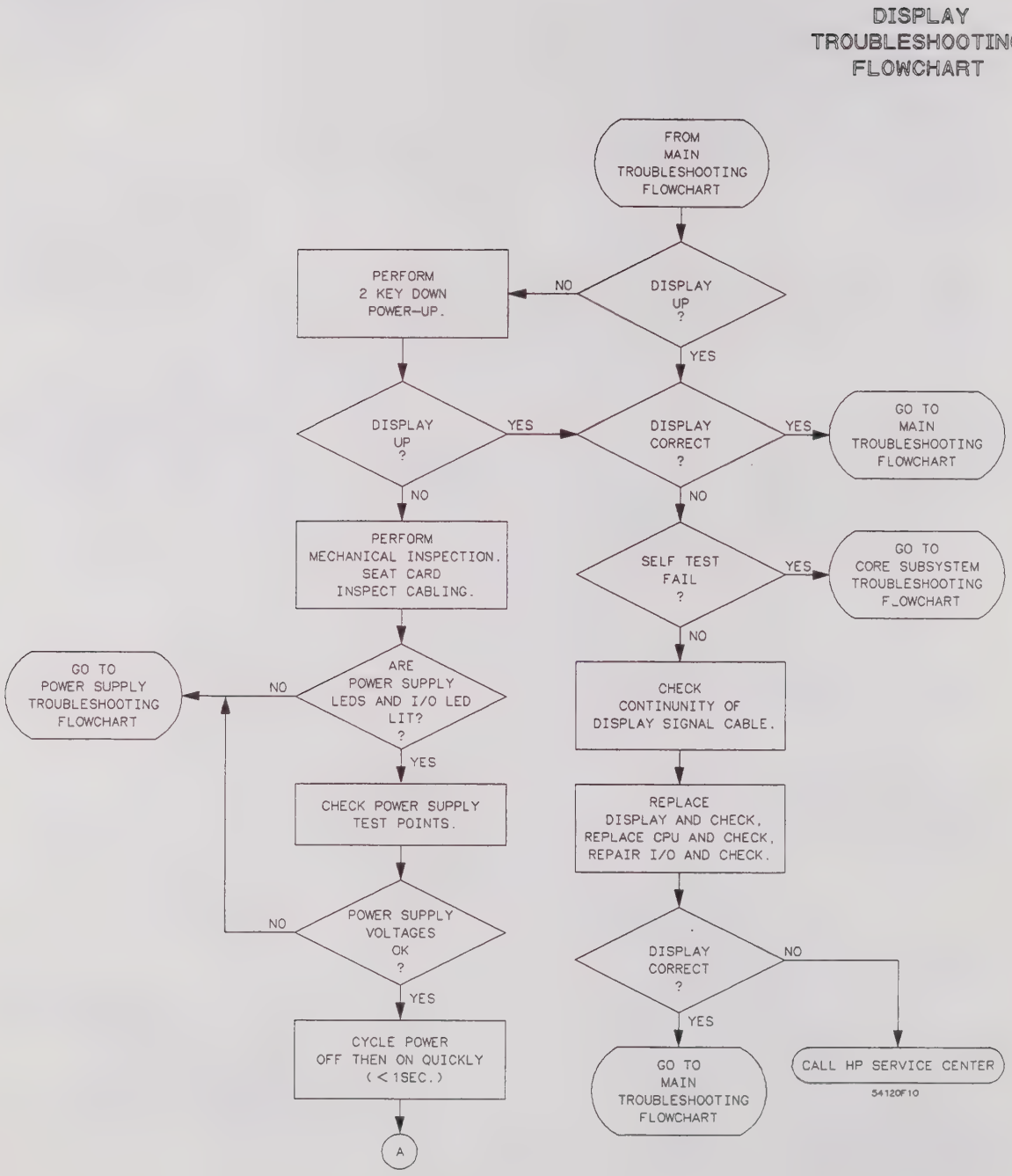


Figure 6D-2. Display Troubleshooting Flowchart Part 1

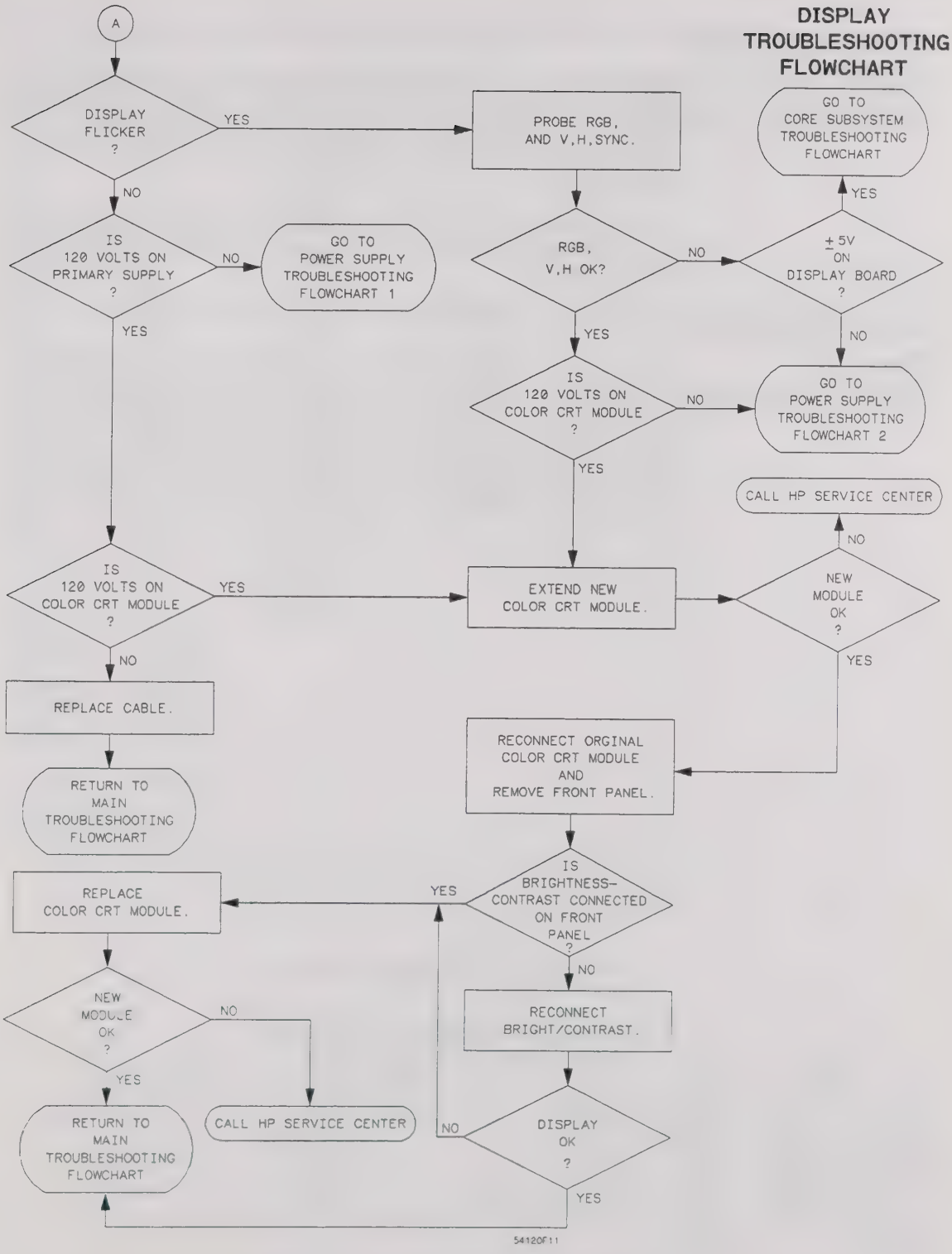


Figure 6D-3. Display Troubleshooting Flowchart Part 2

I/O Assembly Hard Reset

This reset is similar to powering the instrument off and on, except the power supplies are not lowered to 0 V. This reset is useful as a convenient method for resetting the instrument with the top cover removed. It can also be a good troubleshooting aid when there may be a failure with the instrument's normal power up routine.

Anytime the instrument has a power up problem it may help isolate the problem by trying the I/O assembly hard reset. Especially if the instrument has intermittent power up problems.

Keyboard Troubleshooting

Troubleshooting the keyboard uses flow diagram figure 6D-6 to isolate the faulty assembly to the I/O assembly, control keyboard, RPG, function keyboard, menu keyboard, or three interconnecting ribbon cables. Table 6D-2 describes what type signals are on the ribbon cables and figure 6D-5 is the cable's pin descriptions. Table 6D-1 describes which cable row and scan lines are used when the front panel keys are pressed. The softkey name assignments change with the different menu selections. Figure 6D-4 illustrates a numbering scheme for these softkeys.

Figure 6D-4. Softkey Number Assignments

Table 6D-1. Row and Column Key Assignments

	SC0	SC1	SC2	SC3	SC4	SC5	SC6	SC7
RL0	H soft 1	H soft 7	Sec/Volt	0	8	Clear	Autoscale	↑ →
RL1	H soft 2	H soft 8	msec/mV	1	9	Run		← ↓
RL2	H soft 3	V soft 6	µs/µV	2		Stop/Single		
RL3	H soft 4	V soft 5	ns	3		Save		
RL4	H soft 5	V soft 4	ps	4		Recall		
RL5	H soft 6	V soft 3		5		Local		
RL6		V soft 2		6				
RL7		V soft 1		7				

Table 6D-2. Keyboard Ribbon Cable Signal Description

Pin Description	Cable Pin No.	I/O Bd Pin No.	Signal
SC0	6	U12 pin 15	195 Hz, 60 mV to 2.8 V, 87% duty cycle, each slightly shifted in phase
SC1	5	U12 pin 14	
SC2	8	U12 pin 13	
SC3	7	U12 pin 12	
SC4	10	U12 pin 11	
SC5	9	U12 pin 10	
SC6	12	U12 pin 9	
SC7	11	U12 pin 7	
RL0	24	U21 pin 38	Single shot when present
RL1	26	U21 pin 39	
RL2	28	U21 pin 1	
RL3	30	U21 pin 2	
RL4	23	U21 pin 5	
RL5	25	U21 pin 6	
RL6	27	U21 pin 7	
RL7	29	U21 pin 8	
RPG	17	U34 pin 2	
RPG	18	U13 pin 12	
Not Used	13	U40 pin 3	
Not Used	16	U39 pin 6	
Not Used	14	U28 pin 11	
+5 V	1-4	U20 pin 13	+5 V
Not Used	33, 34		
DGND	15, 21, 22		0 V
DGND	31, 32		0 V
Not Used	19		
Not Used	20		

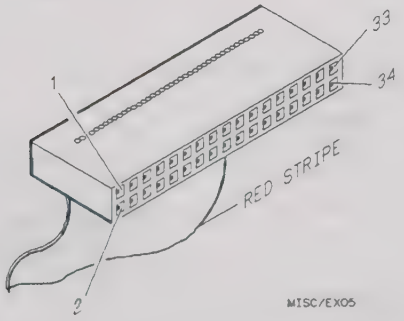


Figure 6D-5. Keyboard Cable Pin Numbers

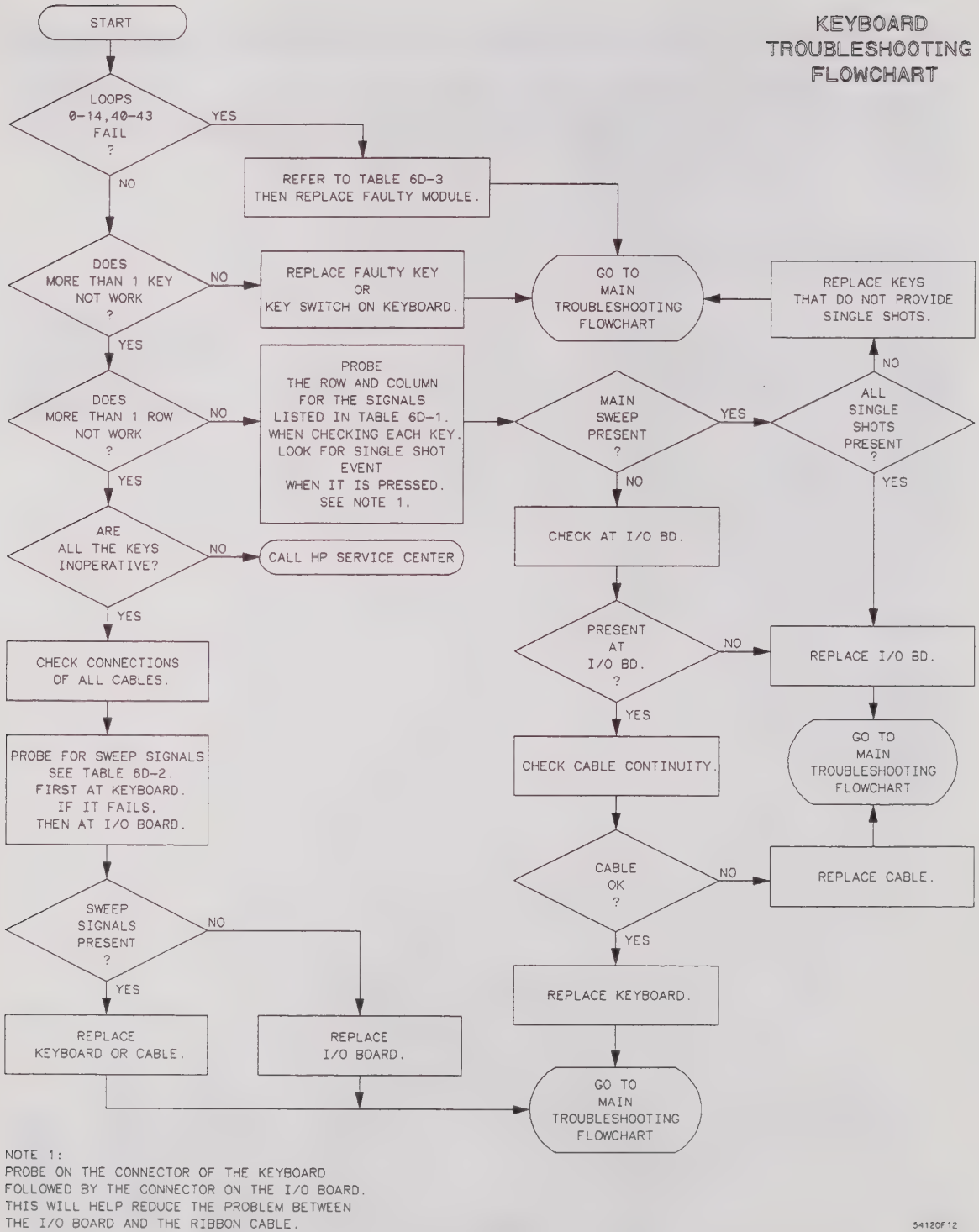

KEYBOARD TROUBLESHOOTING FLOWCHART
START
LOOPS 0-14,40-43 FAIL ?
YES
NO
REFER TO TABLE 6D-3 THEN REPLACE FAULTY MODULE.
DOES MORE THAN 1 KEY NOT WORK ?
NO
REPLACE FAULTY KEY OR KEY SWITCH ON KEYBOARD.
GO TO MAIN TROUBLESHOOTING FLOWCHART
REPLACE KEYS THAT DO NOT PROVIDE SINGLE SHOTS.
YES
DOES MORE THAN 1 ROW NOT WORK ?
NO
PROBE THE ROW AND COLUMN FOR THE SIGNALS LISTED IN TABLE 6D-1. WHEN CHECKING EACH KEY. LOOK FOR SINGLE SHOT EVENT WHEN IT IS PRESSED. SEE NOTE 1.
MAIN SWEEP PRESENT ?
YES
ALL SINGLE SHOTS PRESENT ?
NO
YES
YES
ARE ALL THE KEYS INOPERATIVE?
NO
CALL HP SERVICE CENTER
NO
CHECK AT I/O BD.
YES
CHECK CONNECTIONS OF ALL CABLES.
PRESENT AT I/O BD. ?
NO
REPLACE I/O BD.
YES
PROBE FOR SWEEP SIGNALS SEE TABLE 6D-2. FIRST AT KEYBOARD. IF IT FAILS, THEN AT I/O BOARD.
CHECK CABLE CONTINUITY.
GO TO MAIN TROUBLESHOOTING FLOWCHART
CABLE OK ?
NO
REPLACE CABLE.
SWEEP SIGNALS PRESENT ?
NO
YES
YES
REPLACE KEYBOARD.
REPLACE KEYBOARD OR CABLE.
REPLACE I/O BOARD.
GO TO MAIN TROUBLESHOOTING FLOWCHART
NOTE 1:
PROBE ON THE CONNECTOR OF THE KEYBOARD FOLLOWED BY THE CONNECTOR ON THE I/O BOARD. THIS WILL HELP REDUCE THE PROBLEM BETWEEN THE I/O BOARD AND THE RIBBON CABLE.
54120F12

Figure 6D-6. Keyboard Troubleshooting Flowchart

Core Subsystem Troubleshooting

There are two core subsystem troubleshooting methods. If the loop test information is on the screen, use table 6D-3. If the display or keyboard systems are locked up, use figure 6D-7.

It is preferable to get the HP 54120B to pass all the Core Tests before going on to fix more complex loops. Occasionally, bent motherboard pins or defects in other system elements will cause these loops to fail. Make a system of the microprocessor assembly, I/O assembly and one other assembly. It is than possible to determine which socket or assembly may be causing an interaction that causes one of the core loops to fail. Using this technique, seat each assembly into the motherboard one at a time. Be sure to turn the power off before raising or seating an assembly into the motherboard.

If only the microprocessor and I/O assemblies are seated, the system will go into a repeating multicolored routine with about a two second cycle. This is useful in certain troubleshooting situations but no loop error information will be available.

Table 6D-3. Core Subsystem Diagnostic Routines

Test Loop	**Probable Failing Assembly**
0-4	Microprocessor Assembly
5-9	Display Assembly
10-15	I/O Assembly
40	Microprocessor Assembly
41, 42	Display assembly
43	I/O Assembly

Power Supply Troubleshooting

When a power supply problem is suspected, it is first important to make sure that no unusual load is keeping the supply in a current limited condition. Table 6D-4 indicates which supplies are used on each assembly. Start the power supply troubleshooting with figure 6D-8.

Table 6D-4. Power Supply Distrubution

	+120 V	+18 V	+8 V	+5 V	-5 V	-8 V	-18 V
Microprocessor				*			
Input/Outout †		*	*	*	*	*	*
Horizontal Control		*	*	*		*	*
ADC Assembly		*	*	*		*	*
Color Display				*			
Color CRT Module	*						
To Test Set							
From ADC		*					*
From Horizontal		*	*			*	*

† Only the +5 V is used for power. The other supplies connect for power test only and are high impedance points; the likelihood of loading these supplies is low.

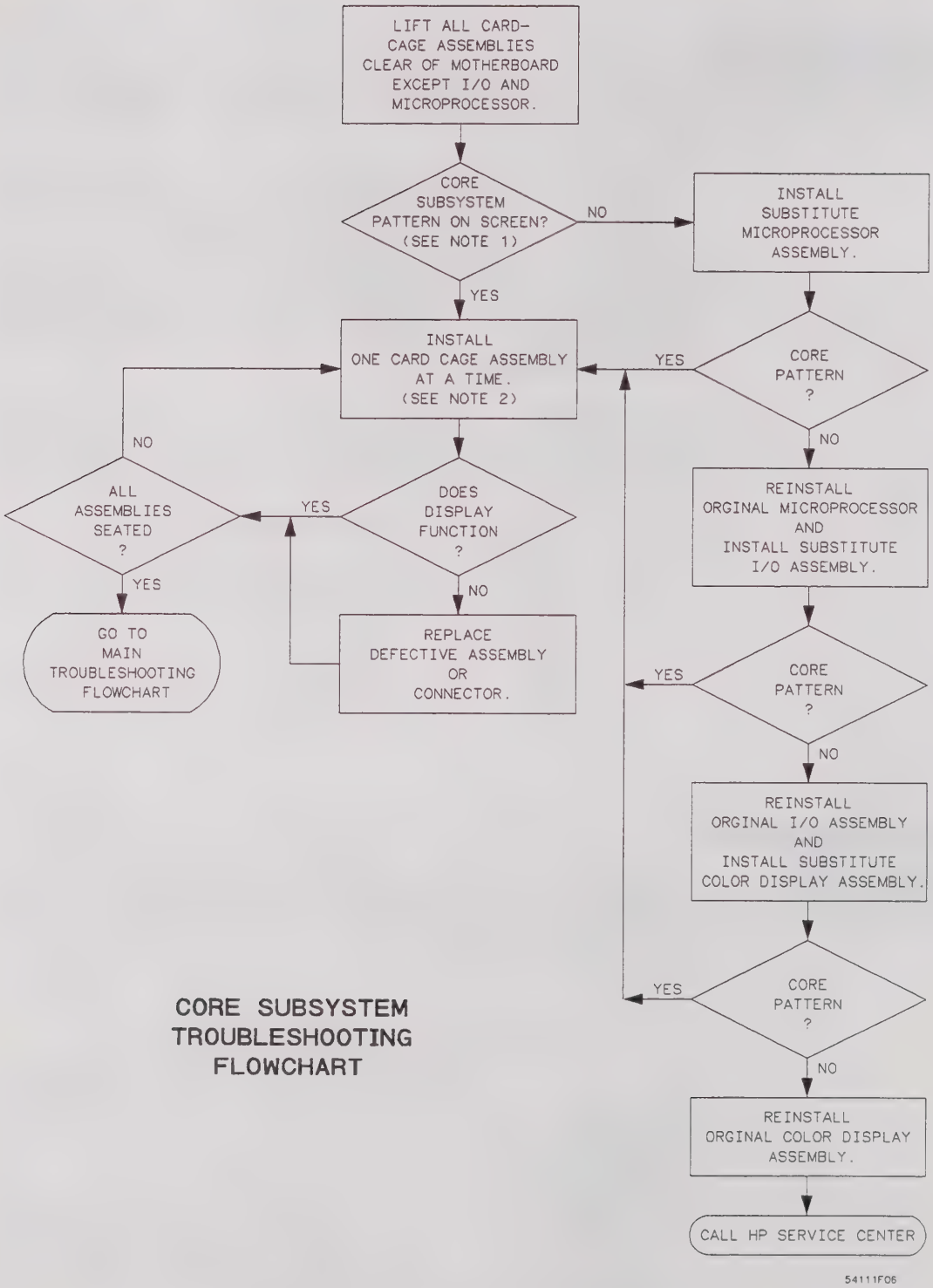


Figure 6D-7. Core Subsystem Troubleshooting Flowchart

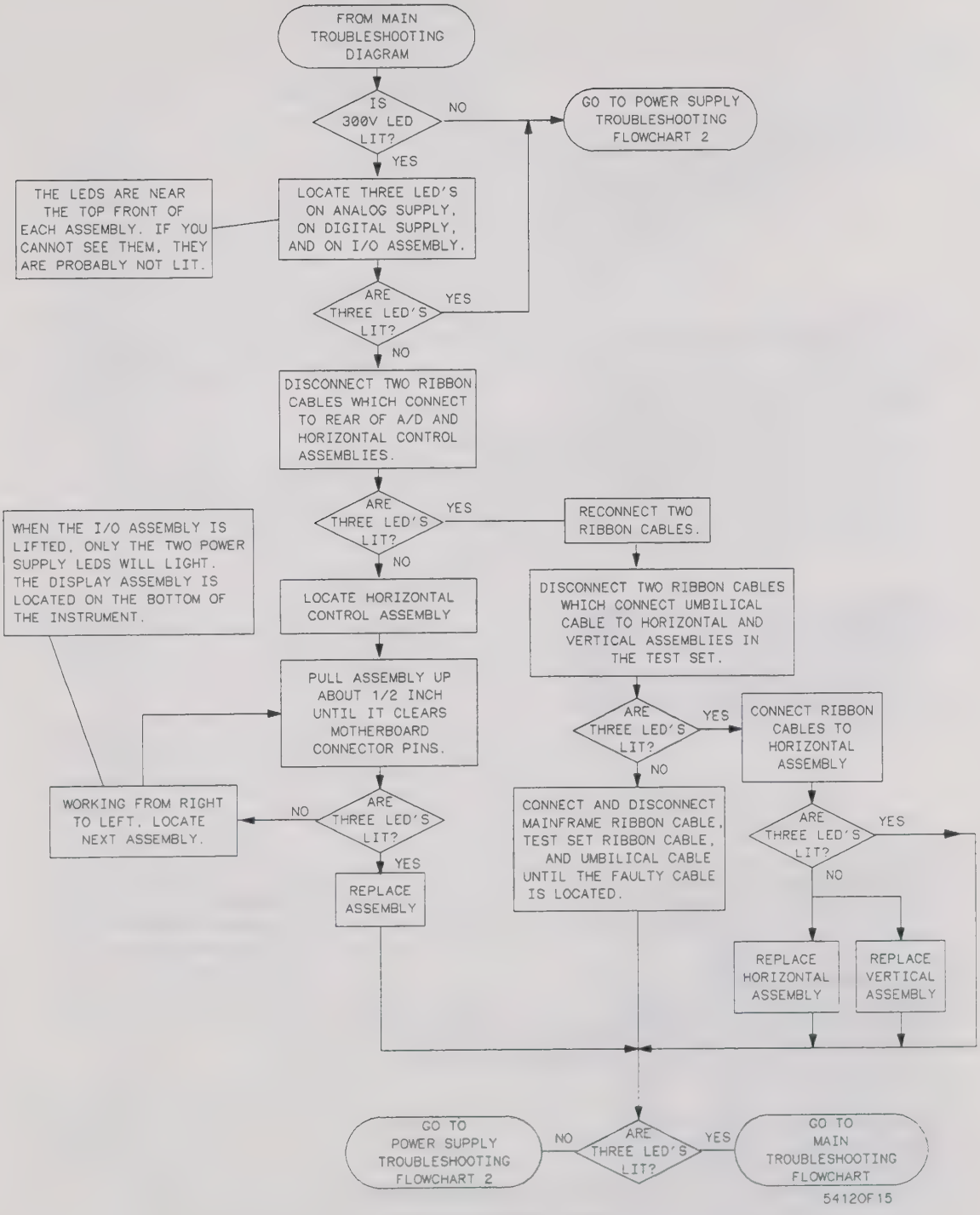
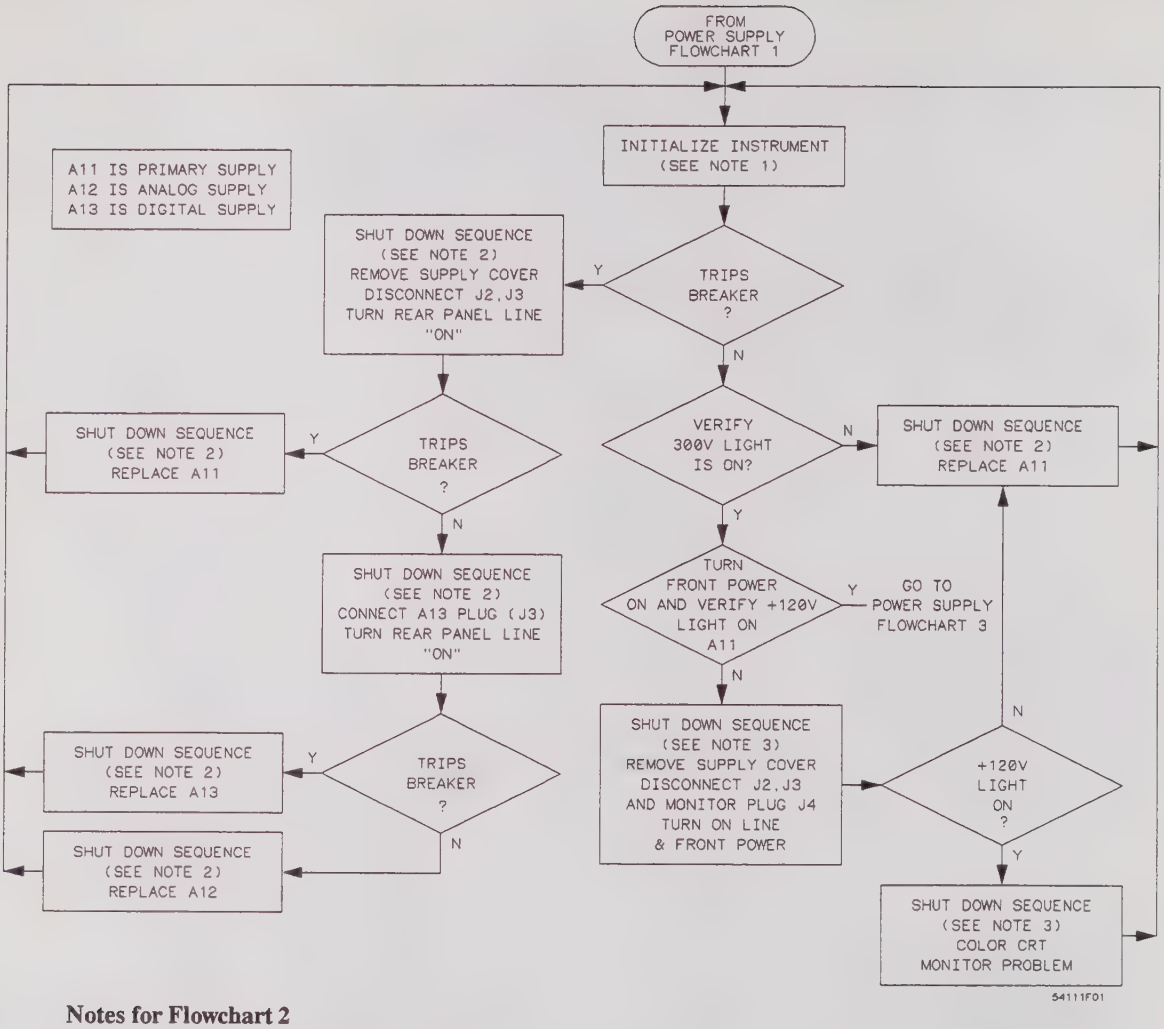

FROM MAIN TROUBLESHOOTING DIAGRAM
IS 300V LED LIT?
NO
GO TO POWER SUPPLY TROUBLESHOOTING FLOWCHART 2
YES
THE LEDS ARE NEAR THE TOP FRONT OF EACH ASSEMBLY. IF YOU CANNOT SEE THEM, THEY ARE PROBABLY NOT LIT.
LOCATE THREE LED'S ON ANALOG SUPPLY, ON DIGITAL SUPPLY, AND ON I/O ASSEMBLY.
ARE THREE LED'S LIT?
YES
NO
DISCONNECT TWO RIBBON CABLES WHICH CONNECT TO REAR OF A/D AND HORIZONTAL CONTROL ASSEMBLIES.
ARE THREE LED'S LIT?
YES
RECONNECT TWO RIBBON CABLES.
NO
WHEN THE I/O ASSEMBLY IS LIFTED, ONLY THE TWO POWER SUPPLY LEDS WILL LIGHT. THE DISPLAY ASSEMBLY IS LOCATED ON THE BOTTOM OF THE INSTRUMENT.
LOCATE HORIZONTAL CONTROL ASSEMBLY
DISCONNECT TWO RIBBON CABLES WHICH CONNECT UMBILICAL CABLE TO HORIZONTAL AND VERTICAL ASSEMBLIES IN THE TEST SET.
PULL ASSEMBLY UP ABOUT 1/2 INCH UNTIL IT CLEARS MOTHERBOARD CONNECTOR PINS.
ARE THREE LED'S LIT?
YES
CONNECT RIBBON CABLES TO HORIZONTAL ASSEMBLY
NO
WORKING FROM RIGHT TO LEFT, LOCATE NEXT ASSEMBLY.
NO
ARE THREE LED'S LIT?
CONNECT AND DISCONNECT MAINFRAME RIBBON CABLE, TEST SET RIBBON CABLE, AND UMBILICAL CABLE UNTIL THE FAULTY CABLE IS LOCATED.
ARE THREE LED'S LIT?
YES
YES
NO
REPLACE ASSEMBLY
REPLACE HORIZONTAL ASSEMBLY
REPLACE VERTICAL ASSEMBLY
GO TO POWER SUPPLY TROUBLESHOOTING FLOWCHART 2
NO
ARE THREE LED'S LIT?
YES
GO TO MAIN TROUBLESHOOTING FLOWCHART
5412OF15

Figure 6D-8. Power Supply Troubleshooting Flowchart 1


FROM POWER SUPPLY FLOWCHART 1
INITIALIZE INSTRUMENT (SEE NOTE 1)
A11 IS PRIMARY SUPPLY
A12 IS ANALOG SUPPLY
A13 IS DIGITAL SUPPLY
TRIPS BREAKER ?
Y
SHUT DOWN SEQUENCE (SEE NOTE 2) REMOVE SUPPLY COVER DISCONNECT J2,J3 TURN REAR PANEL LINE "ON"
N
VERIFY 300V LIGHT IS ON?
N
SHUT DOWN SEQUENCE (SEE NOTE 2) REPLACE A11
Y
TURN FRONT POWER ON AND VERIFY +120V LIGHT ON A11
Y
GO TO POWER SUPPLY FLOWCHART 3
N
SHUT DOWN SEQUENCE (SEE NOTE 3) REMOVE SUPPLY COVER DISCONNECT J2,J3 AND MONITOR PLUG J4 TURN ON LINE & FRONT POWER
+120V LIGHT ON ?
N
Y
SHUT DOWN SEQUENCE (SEE NOTE 3) COLOR CRT MONITOR PROBLEM
TRIPS BREAKER ?
Y
SHUT DOWN SEQUENCE (SEE NOTE 2) REPLACE A11
N
SHUT DOWN SEQUENCE (SEE NOTE 2) CONNECT A13 PLUG (J3) TURN REAR PANEL LINE "ON"
TRIPS BREAKER ?
Y
SHUT DOWN SEQUENCE (SEE NOTE 2) REPLACE A13
N
SHUT DOWN SEQUENCE (SEE NOTE 2) REPLACE A12
54111F01

Notes for Flowchart 2

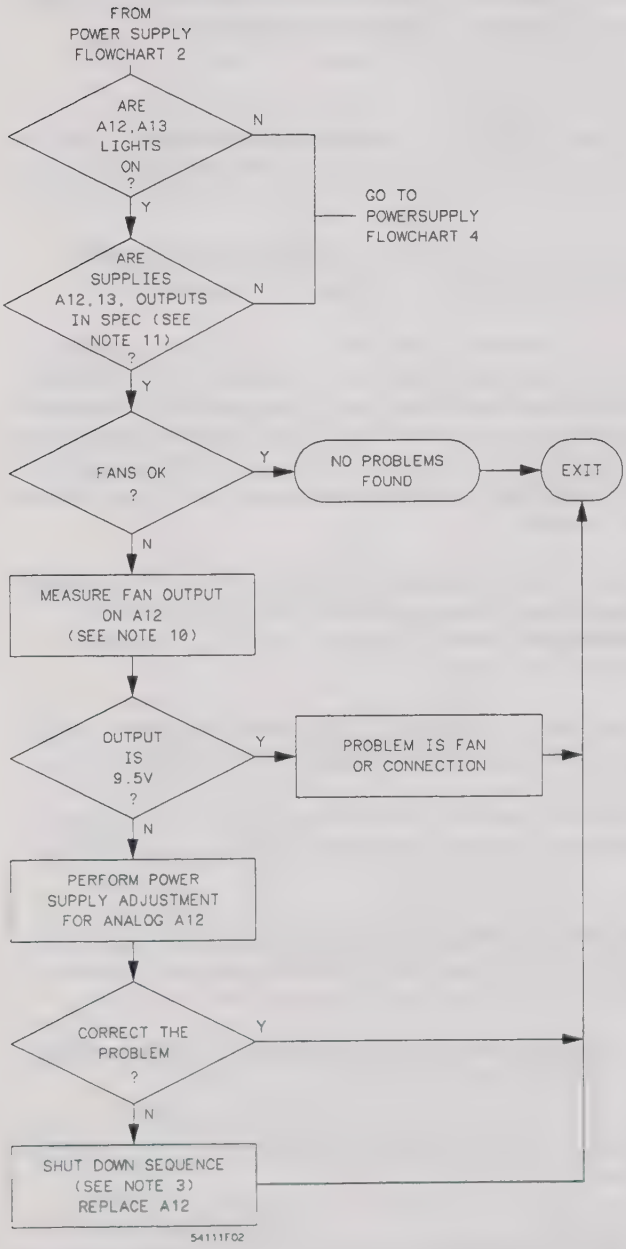
1) A. Turn front panel power switch to standby
   B. Rear panel line switch should be OFF "0"
   C. Connect AC power source
   D. Turn rear panel line switch to ON "1"

2) A. Turn rear panel line switch to OFF "0"
   B. Always unplug AC power source
   C. CAUTION!!! Wait until +300 V light is completely off (about 3 minutes) before proceeding; shock hazard exists and you can cause damage to the instrument

3) A. Turn rear panel switch to standby
   B. Turn rear panel line switch to OFF "0"
   C. Always unplus AC power source
   D. CAUTION!!! Wait until +300 V light is completely off (about 3 minutes) before proceeding; shock hazard exists and you can cause damage to the instrument

Warning
Extreme caution must be taken when removing power supply cover

Figure 6D-9. Power Supply Troubleshooting Flowchart 2



A11 is Primary Supply
A12 is Analog Supply
A13 is Digital Supply

Notes For Flowchart 3

3) A. Turn front panel switch to standby
   B. Turn rear panel line switch to OFF "0"
   C. Always unplug AC power source
   D. **CAUTION!!! Wait until + 300 V ligh is completely off (about 3 minutes) before proceeding; shock hazard exists and you can cause damage to the instrument!!!**

10) Connect the voltmeter (+) lead to the "FAN" test point and the (-) lead to the -18 V test point. The reading should be 9.5 V. This voltage will increase with increasing ambient temperature. See the power supply adjustment procedure for the analog supply.

11) For power supply test points and specifications see table below.

Digital Supply Test Points (+) Lead	(-) Lead	**Voltage**
+5 V	GND	+5.10 V ±0.1 V
-5 V	GND	-5.30 V ±0.1 V
+14B	GND	+5 V
Analog Supply Test Points (+) Lead	(-) Lead	**Voltage**
+18 V	GND	+18.5 V ±0.3 V
+8 V	GND	+8.9 V ±1 V
-8 V	GND	-8.5 V ±1 V
-18 V	GND	-18.5 V ±0.3 V
FAN	-18 V	+9.5 V ±0.3 V
+26B	GND	+5 V

Figure 6D-10. Power Supply Troubleshooting Flowchart 3

Notes For Flowchart 4

3) Turn front panel switch to standby
Turn rear panel line switch to off "0"
Always unplug ac power source

Caution

Wait until +300 V light is completely off (about three minutes) before proceeding; shock hazard exists and you can cause damage to the instrument.

4) The nominal output for +14B is 21V. However, when the supply is operating in the current limit mode, it can be as low as +5 V. The nominal output for +26B is 26 V. It can also be as low as +5 V when in current limit.

5) Measure ±5 V on the digital power supply. If both outputs are ≤ half the normal output, then use the yes path. Otherwise, use the no path.

6) When the supply or supplies are running in the current mode this may mean that an external load is pulling down the supply output(s). An external load could be a board in the card cage or the color display assembly (not the color crt module). the only way to isolate the color display assembly is to completely remove it from the mainframe. The fans can also put the analog board into the current mode. You can disconnect the fans by removing the bottom cover and disconnecting the fan cable.

To isolate a current problem, first disconnect the test set, then remove one load at a time until the problem is found. Problems could include bent pins on the motherboard or a bad component on a PC assembly. Refer to table 6D-4 for power distribution to the various assemblies.

7) Measure ±18 V and ±8 V on the analog supply. If both outputs are ≤ half the normal output, then use the yes path. Otherwise use the no path.

8) The test points to measure +14.6 V are at the back of the board close to the top. Connect the voltmeter common lead to the "COM" test on the board.

Caution

Use caution when measuring this voltage. It is not isolated from the line (mains) input and the primary supply is exposed with the power supply cover removed.

9) By removing the connectors at J2 and J3 you are checking if either the analog or digital supply is loading VCNTL.

Caution

The top pin on connectors J2 and J3 is VBULK which is +300 V. The pins below are VCNTL, then ground.

To measure VCNTL, turn the power off and make sure the +300 V lamp (near top of board) is off. Connect the voltmeter (+) lead to VCNTL (second pin from top) and the (-) lead to ground (bottom pin). Apply power and observe the meter reading. With one supply connected the reading should be about +25 V and with neither connected about +42 V. Turn off power and ensure +300 V LED is off before removing the voltmeter leads.

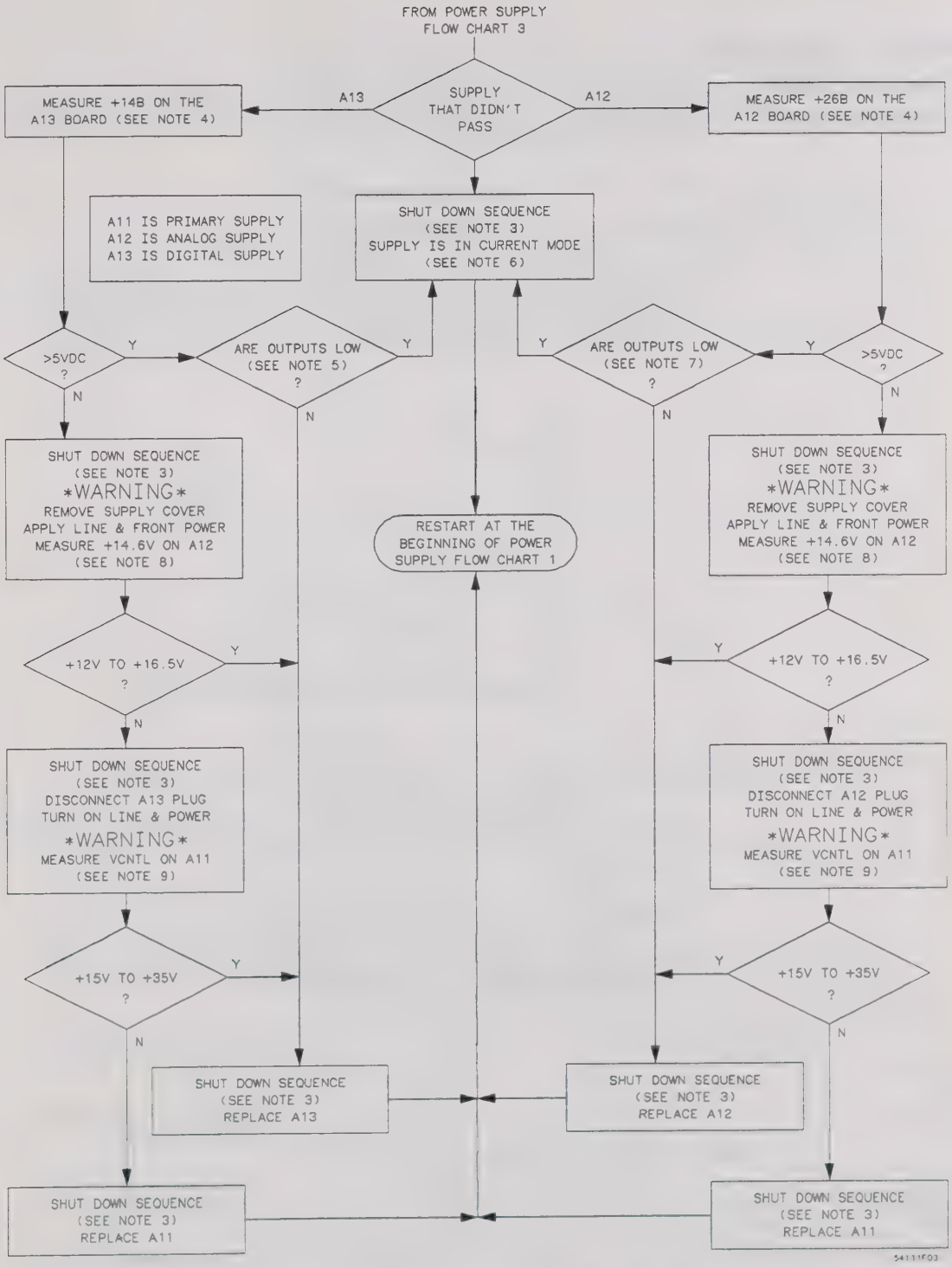

FROM POWER SUPPLY FLOW CHART 3
SUPPLY THAT DIDN'T PASS
A13
A12
MEASURE +14B ON THE A13 BOARD (SEE NOTE 4)
MEASURE +26B ON THE A12 BOARD (SEE NOTE 4)
A11 IS PRIMARY SUPPLY
A12 IS ANALOG SUPPLY
A13 IS DIGITAL SUPPLY
SHUT DOWN SEQUENCE (SEE NOTE 3) SUPPLY IS IN CURRENT MODE (SEE NOTE 6)
>5VDC ?
ARE OUTPUTS LOW (SEE NOTE 5) ?
ARE OUTPUTS LOW (SEE NOTE 7) ?
>5VDC ?
Y
N
SHUT DOWN SEQUENCE (SEE NOTE 3) *WARNING* REMOVE SUPPLY COVER APPLY LINE & FRONT POWER MEASURE +14.6V ON A12 (SEE NOTE 8)
SHUT DOWN SEQUENCE (SEE NOTE 3) *WARNING* REMOVE SUPPLY COVER APPLY LINE & FRONT POWER MEASURE +14.6V ON A12 (SEE NOTE 8)
RESTART AT THE BEGINNING OF POWER SUPPLY FLOW CHART 1
+12V TO +16.5V ?
SHUT DOWN SEQUENCE (SEE NOTE 3) DISCONNECT A13 PLUG TURN ON LINE & POWER *WARNING* MEASURE VCNTL ON A11 (SEE NOTE 9)
SHUT DOWN SEQUENCE (SEE NOTE 3) DISCONNECT A12 PLUG TURN ON LINE & POWER *WARNING* MEASURE VCNTL ON A11 (SEE NOTE 9)
+15V TO +35V ?
SHUT DOWN SEQUENCE (SEE NOTE 3) REPLACE A13
SHUT DOWN SEQUENCE (SEE NOTE 3) REPLACE A12
SHUT DOWN SEQUENCE (SEE NOTE 3) REPLACE A11
SHUT DOWN SEQUENCE (SEE NOTE 3) REPLACE A11
54111F03

Figure 6D-11. Power Supply Troubleshooting Flowchart 4

Color Monitor Troubleshooting

This test determines if the color monitor is faulty by checking horizontal sync pulses (HSYNC), vertical sync pulses (VSYNC), and color pulses (RGB) at the color monitor's input connector.

1. Turn mainframe's power switch to STBY.

2. Remove the mainframe's top and bottom covers.

3. Turn the mainframe's power switch to ON.
   Check the +120 V at the module power connector. Refer to figure 6D-12. The correct voltage should be between +118 V and +122 V. If the +120 V supply is incorrect, refer to the power supply troubleshooting procedure.

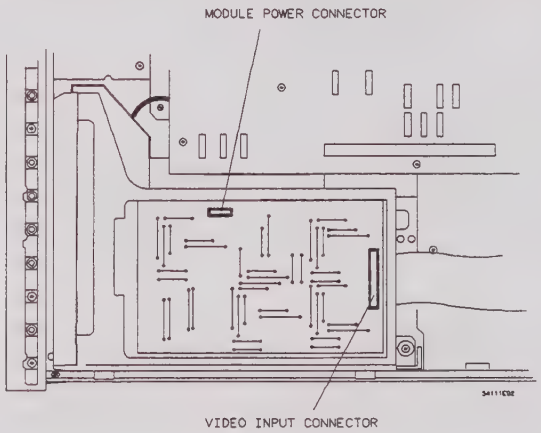


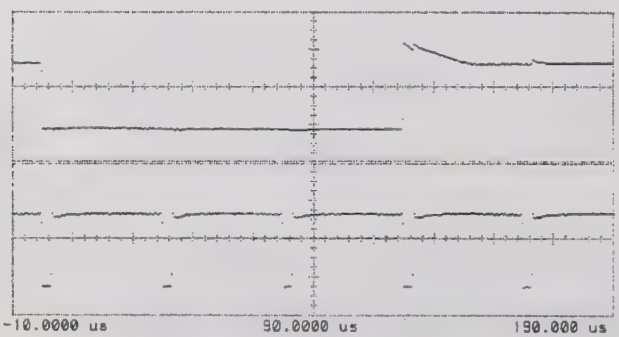
Figure 6D-12. Color CRT Module Input Connections

4. Move the clear plastic shield on the bottom of color CRT module by pushing it rearward until it clears the front frame. Hinge the clear plastic shield away from the board.

5. Connect 10:1 divider probes to monitor oscilloscope. Connect channel 1 to vertical sync test point, pin 3 of video input connector. Connect channel 2 to horizontal sync test point, pin 7 of video input connector. The vertical and horizontal sync pulses are TTL levels and should resemble figure 6D-13.

Vertical Sync Waveform

Horizontal Sync Waveform



Channel 1 = 2.000 V/div
Offset = 2.500 V

Channel 2 = 2.000 V/div
Offset = 2.500 V

Timebase = 20 µs/div
Delay = 90.0000 µs

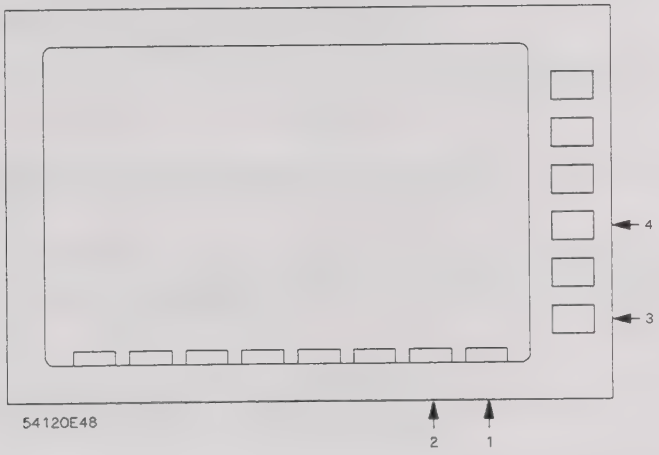
Trigger Mode: Edge
On Neg. Edge on Channel 1
Channel 1 level = 2.300 V

Figure 6D-13. Vertical and Horizontal Sync. Waveforms

6. Before checking the video waveforms, try to get a known display on screen. If the display is operating, press the **More**, **Utility**, **CRT Setup** menu, and **Color Purity** keys. This will place a white raster on screen which means all video signals will be at maximum levels. If there is no display, try to get the same signals by pressing the following softkeys.

In Bottom Row Press:
1. Key at extreme right
2. Key second from right

In Vertical Column Press:
3. Key at bottom
4. Key third from bottom



7. Probe the following points. The video signals have a 0 V baseline and will vary in amplitude from 0 V to approximately 600 mV, depending on the characteristics of the colors displayed.

Video Signal	Video Input Connector
red	21
green	29
blue	37

8. The video signals can be loaded down by the color CRT module's input circuits. If the video signals were bad in step 8, disconnect the cable from the video input connector and recheck the signals on the color display assembly.

Video Signal	J2 on Display Assembly
red	14
green	18
blue	22
Sync Signals	**On Display Assembly**
Vert. sync	V.Sync TP
Horz. sysn	H.Sync TP

9. If the video signals are now good, replace the color CRT module.

Color CRT Module Troubleshooting

It is time consuming to remove a suspected faulty color CRT module from the instrument. This test connects a good color CRT module outside the instrument without having to remove the suspected faulty monitor. This requires the use of parts from the HP 54100 family product support kit.

Warning

Chassis ground on the color CRT module will be disconnected from the chassis ground of the instrument. This will leave the color CRT module chassis ground floating. Therefore, use an alligator clip lead to connect the monitor's chassis ground to the instrument's chassis ground.

1. Turn mainframe's power switch to STBY and remove power cable.
2. Remove mainframe's top and bottom covers.
3. Disconnect color CRT module power cable from primary power supply.
4. Connect a replacement power cable (54110-61601) from the product support kit to the primary power supply.
5. On instrument's bottom side, disconnect the wide ribbon cable from the suspected faulty color CRT module and extend it away from the instrument.
6. Place the known good color CRT module next to the instrument.
7. Connect the wide ribbon cable to the working color CRT module.
8. On the working color CRT module's bottom PC board is a connector labeled B-4, connect the power cable (from step 4) to this connector.
9. On the working color CRT module's bottom PC board is a connector labeled B-2, connect a display control cable from the product support kit to this connector.
10. Connect the CRT brightness control from the product support kit to the other end of the display control cable.
11. Reconnect the power cord and turn the instrument on.
12. If the display is now operational, the suspected faulty color CRT module in the instrument is bad.

Firmware Troubleshooting

Some failures cause the keyboards to lock up and prevent you from entering the troubleshooting menus. This procedure isolates which assembly is causing the problem. After the problem is repaired, return to the flow diagram.

1. Perform two key-down powerup routine.
2. Turn mainframe's power switch to STBY and remove the horizontal and A/D assemblies from the mainframe. Remove the ribbon cables from the assemblies.
3. Turn mainframe on. If there is a graphics pattern (core troubleshooting pattern) repeated displayed, go to step 4; otherwise go to step 10.
4. Turn mainframe's power switch to STBY and install the horizontal control assembly in the mainframe. Do not connect the ribbon cable.
5. Turn the mainframe's power switch to ON. If the core troubleshooting pattern is displayed on screen and the keyboards and display are still functional, go to step 6; otherwise replace the horizontal control assembly and return to flow diagram.
6. Turn the instrument's power switch to STBY and install the A/D assembly in the mainframe. Do not connect the ribbon cable.
7. Turn mainframe on. If the keyboards and display are still functional, go to step 8; otherwise replace the A/D assembly and return to flow diagrams.
8. Turn the mainframe's power switch to STBY and connect the ribbon cable to the horizontal control assembly only.
9. Turn mainframe on. If the keyboards and display are still functional, go to step 9; otherwise continue with step 8's instructions. Disconnect umbilical cable from test set. If display and keyboards are still functional, replace the horizontal assembly in the test set and return to the flow diagram. Disconnect umbilical cable from the mainframe. If the display and keyboards are still functional replace the umbilical cable and return to the flow diagram; otherwise replace the ribbon cable.
10. Turn the mainframe's power switch to STBY and connect the ribbon cable to the A/D assembly only.
11. Turn mainframe on. If the keyboards and display are still functional, go to step 9; otherwise continue with step 9's instructions. Disconnect umbilical cable from test set. If display and keyboards are still functional, replace the vertical assembly in the test set and return to the flow diagram. Disconnect umbilical cable from the mainframe. If the display and keyboards are still functional replace the umbilical cable and return to the flow diagram; otherwise replace the ribbon cable.

12. Replace the following assemblies in order and check the core troubleshooting pattern each time: CPU assembly, display assembly, I/O.

13. Return to the flow diagram.

Additional Troubleshooting

Data acquisition and internal diagnostic troubleshooting is included in the four channel test set service manual.

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General Information A1

Safety and Handling Precautions

Precautions that apply generally to Hewlett-Packard equipment, including the HP 54007A Accessory Kit, are explained in the Safety Considerations page. The devices in the kit, however, are not mechanically, electrically, or chemically hazardous, so no special safety precautions are necessary.

Extreme care must be taken in handling and storing these devices to protect them from mechanical damage. This is especially true in making connections, in order to avoid damaging the connectors and to avoid damaging the HP 54120 system by electrostatic discharge (ESD). A detailed discussion of connection procedures appears later in this manual.

The devices in the HP 54007A Accessory Kit have very precise mechanical tolerances, some on the order of one ten-thousandth of an inch (a few microns). Therefore, rough handling of any kind must be avoided. Do not permit any of the devices to fall on any hard surface or come in contact with dirt, oils, or abrasives. The connectors must be clean and undamaged to ensure an accurate calibration.

The foam-lined storage case in which you receive the accessory kit is the best place to store the devices. Never store any of the devices loose, in a desk drawer, or place them contact-end down on a table top. The lid of the storage case is detachable and allows convenient storage, even in a shallow desk drawer.

Incoming Inspection

The foam-lined storage case provides enough protection for the accessory kit during shipping. If the case arrives in good condition, the devices are probably in good condition. If the case or devices appear to have been damaged, set aside the accessory kit and all packaging materials, contact the nearest Hewlett-Packard sales/support office.

Hewlett-Packard will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company.

Equipment Required But Not Supplied

If you will be using SMA connectors in your calibrations or test setups, a precision connector gauge for measuring the contact pin locations of SMA connectors, as well as for connecting 3.5 mm precision connectors, is recommended. Please read the caution about SMA connectors (see Chapter 3 of this appendix, "Device Specifications"). Precision connector gauges for SMA connectors are available from Maury Microwave Corporation.

A few tools are required to make safe and repeatable connections with either the precision 3.5 mm connectors or SMA connectors.

- Torque wrench (optional) capable of 8 lb-in (90 N-cm) to install precision 3.5 mm devices to each other and the front panel connectors (HP part number 8710-1765).

- Torque wrench (optional) preset to 5 lb-in for mating SMA connectors to precision 3.5 mm connectors (HP part number 8710-1582).

All precision 3.5 mm connectors must be visually inspected before use and cleaned (or replaced) as needed. The following equipment is required for cleaning:

- An illuminated, 4-power magnifying glass for visual inspection of the connectors. The exact power of the glass is not critical, but the type of illumination is. Ordinary room lighting, or oblique lighting from a desk lamp casts shadows that can easily mask the small defects you are trying to see. Therefore, make sure that the magnifying glass has built-in lighting and provides axial, shadowless illumination. Illuminating magnifying glasses are available from most equipment suppliers. Hewlett-Packard does not sell or recommend any particular model.

- Compressed air in a pressurized can, HP part number 92193Y, can be used to blow dust and lint from the connectors. Any source of clean, dry, low-pressure air can be used if it has an effective oil-vapor filter and condensation trap placed just before the air outlet hose.

When using compressed air from a pressurized can, hold the can upright. If the can is tilted or inverted, the liquid propellant sprays out with the air. The propellant evaporates instantly on the connector surface and causes the connector to become too cold for the calibration to continue. If this happens, you must wait until thermal equilibrium is re-established within the allowable temperature range before continuing the calibration. Permanent connector damage from the propellant is unlikely.

- Liquid Freon (trichlorotrifluoroethane), HP part number 8500-1914, CD 7, is the only cleaning solvent recommended by Hewlett-Packard for cleaning 3.5 mm connectors. Several types of liquid Freon exist, so make sure that the kind you use contains only trichlorotrifluoroethane. Some other types contain harmful compounds which can damage precision connectors. A liquid is preferred over spray because the liquid can be applied sparingly and selectively. If a spray must be used, spray the cleaning swab only, not the connector.

Do not use any solvents other than liquid Freon. They can leave residues that react destructively with the metal plating on the connectors, or erode essential plastic dielectric supports. Along with your supply of solvent, keep a microscope slide or a similar piece of clear glass to check the solvent periodically for contamination.

- Plastic foam swabs, HP part number 9300-0468 CD 1, are used along with liquid Freon to clean the connector surfaces. These swabs resemble common swabs, but have lint-free plastic foam tips.

Accessory Kit Devices A2

Introduction

This chapter describes and explains the uses of the components of the HP 54007A Accessory Kit. All precautions apply to the uses covered in this chapter.

7.5 cm Beadless Airline

A 7.5 cm beadless airline has been included in the HP 54007A Accessory Kit for use in discontinuity separation and isolation. This device, although not a perfect termination, can improve and reduce reflections, increase the round-trip time of reflections, or isolate perturbations in the circuit.

The airline is a known 50 Ω load and is a good reference. Due to this fact, the primary uses are as follows:

1. The primary use of the 7.5 cm beadless airline is to separate perturbations. If you place a known load between perturbations you can separate known perturbations from those in the device-under-test and evaluate each individually.

2. The airline can be used as a precision 50 Ω load during reflection calibrations. Place the airline at the reference plane and increase the timebase until the end of the airline is offscreen (to the right). This yields a 50 Ω reference dependent only on the mechanical dimensions of the airline.

3. By placing the airline on the four channel test set, the device-under-test can be separated from the incident edge. This is convenient for viewing data that is close to the incident edge, plus you can see the 50 Ω reference more clearly in relation to the device-under-test.

Connecting the 7.5 cm beadless airline is a very sensitive procedure. More care must be taken than for normal connections. First verify that the center conductor is properly oriented when installed; the male end of the center conductor should be at the end of the outer conductor with the connector nut.

Caution

Wear a grounded wrist strap and discharge static electricity by grasping the outer shell of the test port briefly before you begin making the connection. When connecting the airline, you are touching exposed center conductors that are connected to the internal circuits of the HP 54120 series.

The airline is small, and the center and outer conductors are almost the same length, so connecting the center conductor at the same time as the outer conductor is difficult. But, it is also difficult to slide the outer conductor over the center conductor without risking damage to the inner surface of the outer conductor. Therefore, check the center conductors to see if they have mated after the outer conductors have been loosely connected. Pressing gently on the end of the center conductor with a plastic rod will usually mate the conductors.

Connect the airline as follows:

1. Retract the connector nut on the airline fully. Put the center conductor into the airline and verify that the female end of the center conductor emerges from the female end of the outer conductor. This end will be connected to the test set.

2. Hold the airline and center conductor, bring both the airline and center conductor to the test port connector. Carefully align and mate the center conductors. Then make a preliminary connection by fastening the test set connector nut finger tight. In handling the center conductor, use lint-free gloves or finger cots.

3. When the preliminary connection has been made, verify that the center conductors have mated by pressing gently on the end of the center conductor with a plastic rod.

4. Connect the termination device to the opposite end of the airline. Carefully align and mate the center conductor of the device with the center conductor of the airline. Then make a preliminary connection of the terminating device and the airline by fastening connector nut finger tight.

Now make the final connections:

5. Start at the test port with the counter-rotation technique (see Figures A4-8 and A4-9) to eliminate air wedges from this connection. After counter-rotation, retighten the connection finger tight and use a torque wrench to make the final connection. Support the airline when making connections to avoid applying lateral or vertical (bending) force.

6. Tighten the connection of the termination device or adapter on the airline with the counter-rotation technique. You will have to hold the airline firmly to prevent loosening the test port connection. After counter-rotation, retighten the connection finger tight and use the 3.5 mm connector torque wrench to make the final connection.

Disconnect the airline by reversing the above procedure.

15 cm Beadless Airline

The 15 cm airline is not included in the HP 54007A Accessory Kit. This device will enhance testing lines and reading reflections by extending the time before they are returned and displayed. The time extension is significant. It will allow you to take measurements without the fear of a known perturbation in the circuit. The 15 cm beadless airline gives greater separation between a known perturbation and perturbations of the device-under-test.

Connection procedures are the same as for the 7.5 cm airline.

The HP 54007A storage box has been designed to accommodate the 15 cm beadless airline.

Model 909D 50 Ω Terminator

The HP 909D is a precision, low-reflection load for terminating 50 Ω coaxial systems in their characteristic impedance. When trying to normalize out gross perturbations the precision 50 Ω becomes more important. The HP 909D is used to improve the quality of precision reflection measurements and normalize the HP 54120 system to precision specifications.

The HP 909D comes with the rugged APC-3.5 connector for measurement repeatability even after hundreds of connections.

The performance is specified to 26.5 GHz. Based on limited tests the expected SWR at 34 GHz is in the range of 1.3, and the HP 909D will operate to 39 GHz before higher mode resonances have any significant effect.

Impedance stability with both time and temperature, a key parameter for precision terminations, is achieved by using tantalum nitride on sapphire thin film technology.

Maintenance

The HP 909D is used for precise measurements so it must be kept in top operating condition. Hewlett-Packard recommends that the connector be inspected periodically and cleaned if necessary. It is also recommended that the HP 909D be verified annually or after 1000 connections.

Specifications

Frequency Range: dc to 26.5 GHz

Impedance: 50 Ω

SWR: 1.02, dc-3 GHz 1.036, 3-6 GHz 1.12, 6-26.5 GHz (At 26.5 GHz the typical SWR is 1.1. Statistically, 90% of the terminators produced will meet this performance).

Power Rating: 2 W ave. @ 20° C derated to 1 W ave. at 75° C 100 W peak (10 μs max. pulse width) @ 20° C

Connector: APC-3.5 male; Opt.. 011, APC-3.5 female.

Dimensions: 23 mm x 4 mm diameter (0.91 in x 0.16 in diameter).

Environment

In a non-operating environment the terminator should be stored in a clean, dry place. The following environmental limitations apply to both storage and shipment (unless stated otherwise in the Data Sheet).

- Temperature: -55° C to +75° C
- Humidity: 95% relative @ +40° C
- Altitude: 15,300 metres (50,000 ft)

The operating environment of the instrument should be within the following limitations (unless stated otherwise in the Data Sheet).

- Temperature: 0° C to +55° C
- Humidity: 95% relative at +40° C
- Altitude: 4500 meters (15,000 ft)

Caution

Storage or operation of the instrument in an environment other than that specified may cause damage to the instrument and may void the warranty.

Coaxial Attenuators

The HP 33340C coaxial fixed attenuator offers broad frequency coverage, low SWR and small size. The attenuator is available in nominal attenuation values of 3, 6, 10, 20, 30 and 40 dB. It is fully tested to meet specifications at all frequencies and over most of the frequency band. It will typically perform much better than specified.

The HP 33340C attenuator is included in this kit in the 6 dB and 40 dB values.

Applications

One of the main applications is to reduce the power to critical microwave circuits and avoid possible damage. Another application is to "pad" badly matched devices, such as mixers in order to minimize SWR. Use of the HP 33340C will not only protect your instrument, it also increases the input signal range.

Specifications

Frequency range: dc - 26.5 GHz

Attenuation Accuracy:	6 dB	40 dB	
dc-18.0 GHz	0.6 dB	1.0 dB	
dc-26.5 GHz	0.6 dB	1.3 dB	
SWR: 6 dB	40 dB		
dc-8 GHz	1.10	1.10	
8-12.4 GHz	1.15	1.15	
12.4-26.5 GHz	1.27	1.25	
Attenuation Range:	6 dB	40 dB	20 dB
	2.0	100	10

Temperature, stability: 0.0002 dB/dB/@C

Maximum input power: 2W ave @ 20° C derated to 1 W ave at 75°C, 100 W peak

Power sensitivity: 0.001 dB/w

Connectors: APC-3.5 (m-f)

Weight: 8.5 g (0.3 oz)

Environmental

- Temperature, non-operating: -55° C to +85° C
- Temperature, operating: -40° C to +75° C
- Altitude, non-operating: 50,000 feet Altitude, operating: 15,000 feet Humidity: cycling 5 days, 40° C at 95% RH with condensation
- Vibration: 7 G's 5-2000 Hz Shock: 500 G's, 1.8 ms in six directions. EMC: radiated interference is within Mil Std. 461 method RE02, VDE 0871 and CISPR Publication 11.

Coaxial Short

The coaxial short is a precision, low-inductance device that will give an accurate representation of frequency information of reflected energy. It can provide a precision reference point for TDNA calibration as a time reference. It can be used to determine a baseline reference (voltage) for absolute ground.

The short is used in calibration of dielectric and velocity constants because it has a precision time offset of 21.17 ps and can be either deducted out of measurements, or more commonly, the offset is 1% and has no bearing on the measurement.

Both male and female shorts have the same electrical length.

Test Port Return Cables

The 17 inch test port return cables are used in performance verifications (see HP 54120 system service manuals.). They are included in the HP 54007A Accessory kit for low loss network measurements. And they are flexible for hard-to-access areas. The lengths are matched so that the reflection path length equals the transmission path length and both measurements can be made in the same timebase setting. The flexible cables are not precision impedance devices.

The cables included in the accessory kit have female-to-female and male-to-female end connectors. The male and female ends of the two cables allow direct connection for calibrating the transmission path. This implies that the device under test should be equipped with male and female connectors. Refer to paragraph in this chapter titled "Adapter (m-m)".

Characteristics

Impedance: 50 Ω

Capacitance: 26 pF/ft (85.3 pF/metre)

Time delay: 1.2 ns/ft (3.9 ns/metre)

Velocity of Propagation: 85% of C

Dielectric Constant: 1.4

Jacket Withstand: 1.0 kV

Dielectric Withstand: 1.0 kV

Center Conductor: 15 AWG solid
Minimum Bend Radius: 25 mm (1 inch)

To prolong the life of these cables, minimize repeated bending to a tight radius. Do not exceed the 25 mm radius specification.

VSWR

2-4 GHz 1.15
4-8 GHz 1.25
8-18 GHz 1.30
18-26.5 GHz 1.35

Insertion Loss

0-4 GHz 0.36 dB
4-8 GHz 0.50 dB
8-12 GHz 0.60 dB
12-16 GHz 0.72 dB
16-18 GHz 0.80 dB
18-26.5 GHz 1.0 dB

Note

VSWR and Insertion loss are typically 10% better than characterized.

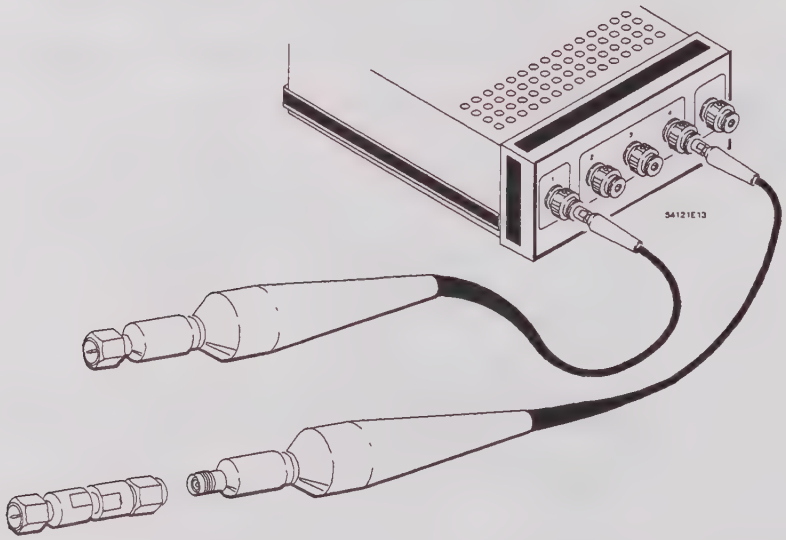


Figure A2-1. Test Port Return Cables

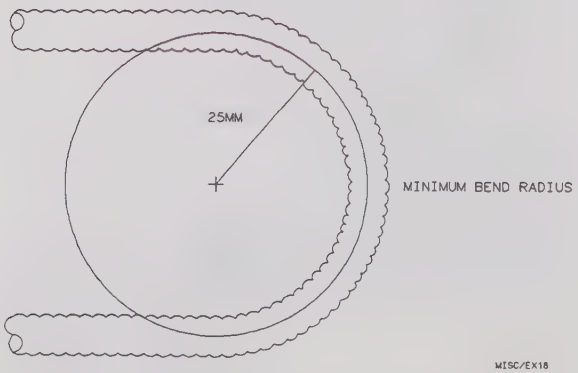


Figure A2-2. Minimum Bend Radius

Adapter (m-m)

The m-m adapter is a precision APC-3.5 device used to change connector sex. Many situations will arise when both ends to be connected are female. Placing a m-m adapter will not change the circuit characteristics other than the electrical length. The electrical length is approximately 137 ps and the mechanical length is 41 mm. These dimensions are approximate and should be verified before any critical measurements are made.

If, when using the test port return cables, the input has two female connections, this adapter can be connected to the device-under-test. This hook-up will add 137 ps to your measurement.

Semi-Rigid L Connectors

The semi-rigid "L" connectors are used to create network connections and access different channels or functions simultaneously. This allows you to view the trigger signal, attenuate the TDR signal, or connect and configure any way you desire.

Power Splitter

This section contains operating and service information for the HP 11667B power splitter. It explains how the operator checks this device and describes the one performance test required to test tracking between the output arms.

Description

The HP 11667B is a two-resistor power splitter used in oscilloscope measurement systems that have one output arm for triggering the HP 54120 system. The power splitter is useful for making attenuated TDR measurements.

Safety Considerations

Do not apply more than +27 dBm RF CW power to the HP 11667B, or the power splitter may be damaged.

Specifications

These are performance standards or limits against which the instrument may be tested.

Frequency Range: dc to 26.5 GHz

Maximum Input Power: +27 dBm (0.5W)

	dc to 18.0 GHz	dc to 26.5 GHz
Input SWR:	1.22	1.29
Equivalent Output SWR: (leveling or ratio measurement)	1.22	1.22
Output Tracking: (between output arms)	0.25 dB	0.40 dB

Connectors: Precision 3.5 mm (f) on all ports

Dimensions: 47 mm X 40 mm X 10 mm (1.85 in x 0.39 in)

Shipping Weight: 0.14 kg (4.94 oz)

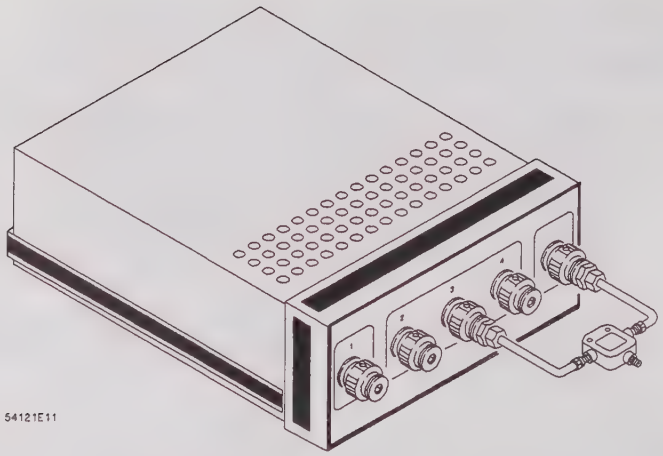


Figure 2A-3. Viewing the Trigger Signal

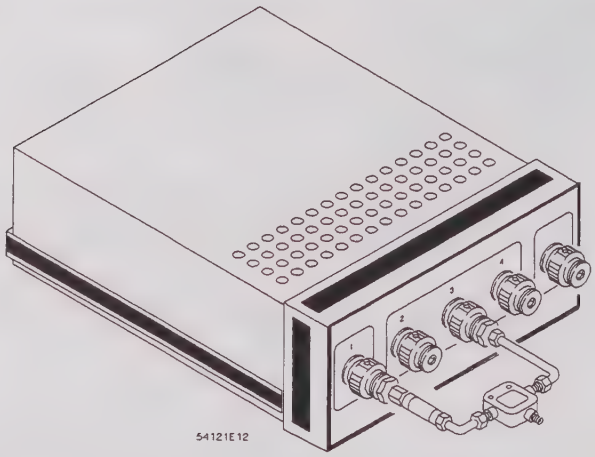


Figure 2A-4. Attenuating the TDR Signal

Supplemental Characteristics

These are not specifications, but typical characteristics included as additional information for the user.

Frequency (GHz)	dc to 18.0	dc to 26.5
Phase Tracking (between output arms)	1.5°	2.5°
Output Tracking	0.25 dB	0.40 dB

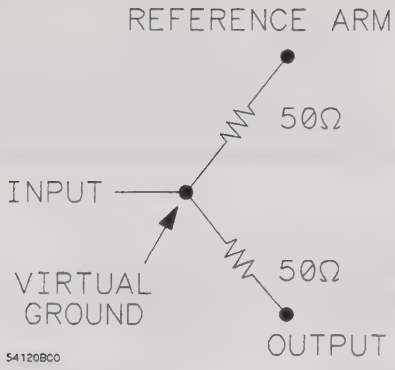


Figure A2-5. HP 11667B Power Splitter Schematic

Connections

Follow all handling precautions discussed in chapter A4 and maintain all device specifications while handling, connecting, or disconnecting the power splitter.

Operating Environment

- Temperature, 0° C to 55° C (32° F to 131° F)
- Humidity, Up to 95% relative
- Altitude, Up to 4,572 metres (15,000 feet)

Storage and Shipment

- Temperature, -40° C to +75° C (-40° F to +167° F)
- Humidity, Up to 95% relative
- Altitude, Up to 7,620 metres (25,000 feet)

Protect the HP 11667B from temperature extremes that could introduce internal condensation.

Features

1. Input port for incoming signal.

2. 3. Output ports used as exit ports. Output signal is 6 dB down in power from input signal. Either port may be used as test or reference port since power is equal in both ports.

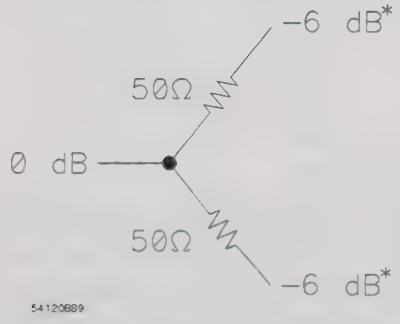


Figure A2-6. HP 11667B Power Splitter Insertion Loss

Making Accurate Measurements A3

Introduction

This chapter acquaints you with the operating conditions and procedures necessary to use the devices properly. Familiarize yourself with this information before trying any measurements.

Hewlett-Packard guarantees that the performance of your calibration devices will equal or exceed the listed specifications. Certain operating procedures must be followed if these specifications are to be met and maintained, due to the precision of the devices and to the performance capabilities of the HP 54120 system.

The performance of the TDNA calibration devices described in Device Specifications are the performance values guaranteed by Hewlett-Packard. Characteristics are typical, or nominal, values.

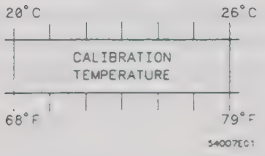
Operating Conditions and Procedures

Temperature, wear of the precision 3.5 mm connectors, and operator skill can all significantly affect the accuracy and repeatability of microwave measurements.

Temperature

Temperature of the calibration devices is critical because the dimensions of the devices (electrical characteristics) change with temperature. Figure A3-1 illustrates the allowable environmental conditions for using the HP 54007A kit. These conditions must be met if accurate measurements are to be obtained.

Note that the operating temperature during calibration and actual device measurements must be 20-26° C (68-79°F). During device measurements, the operating temperature must be within ±1° C (1.8° F) of the temperature during calibration. Thus, if the calibration was done at 22° C (71.6° F) the operating temperature must be 21-23° C (69.8-73.4° F). If the work area is subject to temperature fluctuations, you might want to record the temperature at which the calibration is made, to assure repeatability and accuracy.



Operating temperature during actual measurements must be within ±1° C (±1.8° F) of the calibration temperature.

Storage temperature: Min -40° C (-40° F) Max +65° C (+149° F)

Relative humidity: 20-80% (30° C maximum wet bulb) during operation, 5-95% during storage; non-condensing at all times.

Figure A3-1. Allowable Temperature, Humidity, Pressure

Barometric pressure (expressed as altitude): < 4500 metres (15,000 ft) during operation, < 15,000 during storage.
The temperature of the calibration devices and all connectors must be stable before use. Devices kept with the oscilloscope are usually at a stable temperature and can be used immediately. Devices that have been moved from one location to another should be allowed to reach the same temperature as the oscilloscope.

Heat Source

Your fingers are also a heat source. Normal body temperature is 37° C (98.6° F). You should avoid unnecessary handling of the devices during use. Some devices have a plastic jacket over the connector body to provide thermal insulation during handling. Barometric pressure and relative humidity also affect device performance, although less than temperature. Air exists between the inner and outer conductors of these devices (air-dielectric devices), and the dielectric constant of air depends on pressure and humidity. Refer to Figure A3-2.

Wear

Connector wear will eventually degrade performance. The calibration devices, which are typically used only a few times each day, should have a very long life. However, because the connectors often undergo many connections a day, they wear rapidly. Therefore, it is essential that all connectors on the HP 54120 system be inspected regularly, both visually (with a magnifying glass) and mechanically (with a connector gage), and replaced as necessary. Procedures for visual and mechanical inspection are given in the next section of this manual. For four channel test sets used in high-volume work, it is best to place an adapter on both the input and the output ports. It is easier and cheaper to replace a worn adapter than a worn four channel test set connector.

Skill

Operator skill in making good connections is essential. The mechanical tolerances of the precision 3.5 mm connectors used in the HP 54007A kit are two or three times better than the tolerances in regular 3.5 mm connectors. Slight errors in operator technique that would go unnoticed with regular connectors often appear with precision connectors in the calibration kit. Incorrect operator technique can often result in lack of repeatability. Carefully study and practice the connection procedures that are explained later in this manual until your calibration measurements are consistently repeatable.

Device Specifications

Electrical specifications depend upon several mechanical conditions. A 3.5 mm connector is a precision connector dedicated to very specific tolerances. SMA connectors are not precision mechanical devices. They are not designed for repeated connections and disconnections and are very susceptible to mechanical wear. They are often found, upon assembly, to be out of specification. This makes them potentially destructive to any precision 3.5 mm connectors with which they might be mated.

Caution

Use extreme caution when mating SMA connectors with 3.5 mm precision connectors. Prevent accidental damage due to worn or out-of-specification SMA connectors. Such connectors can destroy a precision 3.5 mm connector, even on the first connection.

Hewlett-Packard recommends that you keep three points clearly in mind when you mate SMA and precision 3.5 mm connectors:

SMA Inspect

1. Before mating an SMA connector (even a new one) with a precision 3.5 mm connector, carefully inspect the SMA connector, both visually and mechanically with a precision connector gauge designed to measure SMA connectors. A male SMA connector pin that is too long can smash or break the delicate fingers on the precision 3.5 mm female connector. Gauging SMA connectors is the most important step you can take to prevent damaging your equipment.

Alignment

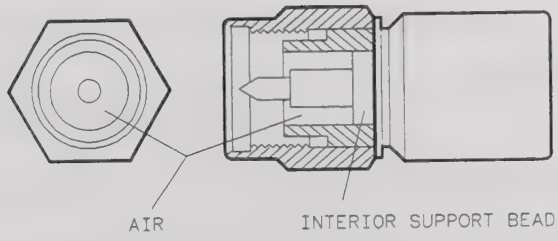
2. Be careful with alignment. Push the two connectors together with the male contact pin precisely concentric with the female. Do not overtighten or rotate either center conductor. Turn only the outer nut of the male connector and use a torque wrench (5 lb.in., 60 N-cm) for the final connection. Note that this torque is less than that when mating precision 3.5 mm connectors with each other. A torque wrench suitable for SMA connectors preset to 5 lb.in. is available (HP part number 8710-1582, CD 0).

   Install an adapter on the four channel test set if many connections and disconnections will be made. Then, if accidental damage does occur, the adapter is all that needs to be replaced. It is easier and cheaper to replace a damaged adapter than an entire four channel test set connector. SMA connectors can then be mated with precision 3.5 mm connectors without difficulty or fear of expensive and time-consuming repairs.

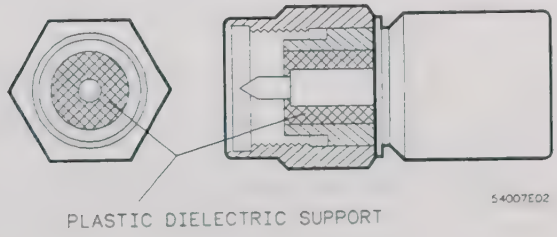
Mismatch

3. Significant structural and dimensional differences exist between these two types of connectors. Precision 3.5 mm connectors, also known as APC-3.5 connectors, are air-dielectric devices. Only air exists between the center and outer conductors. The male or female center conductor is supported by a plastic "bead" within the connector. In SMA connectors, a plastic dielectric supports the entire length of the center conductor. In addition, the diameter of both the center and outer conductors of an SMA differ from that of a precision 3.5 mm connector.

Precision 3.5 mm Connector



SMA Connector



When an SMA connector is mated with a precision 3.5 mm connector, the connection exhibits a continuity mismatch (SWR), typically about 1.10 at 20 GHz. This mismatch is less than when two SMA connectors are mated, but still higher than when precision 3.5 mm connectors are mated. Keep this fact in mind when making measurements on SMA and precision 3.5 mm coupled junctions.

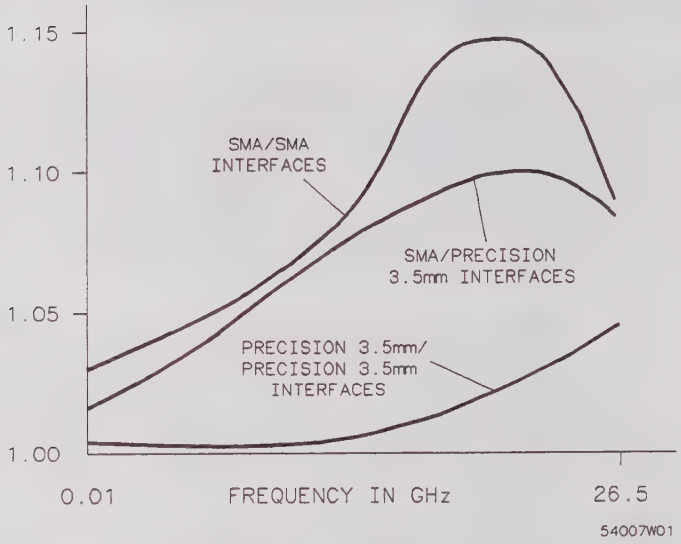


Figure 3A-2. Typical SWR of SMA and APC 3.5 Connectors

Making Good Connections A4

Introduction

This chapter explains the operating procedures which must be followed to obtain an accurate TDNA calibration.

Accuracy requires that 3.5 mm precision connectors be used. However, SMA connectors can be used if special care is taken when mating the two, and all connectors are undamaged and clean. Before each use, the mechanical dimensions of all connectors must be checked with a connector gauge to make sure that the center conductors are positioned correctly. All connections must be made for consistent and repeatable mechanical (and therefore electrical) contact between the connector mating surfaces.

Carefully study and practice all procedures in this chapter until you can successfully perform them repeatedly. Accuracy and repeatability are critical for good microwave measurements. Note that the device connection procedures differ in several important ways from traditional procedures used in the microwave industry. Hewlett-Packard procedures have been developed through careful experimentation.

Handling Precision 3.5 mm Connectors

Precision 3.5 mm connectors must be handled carefully if accurate calibrations and measurements are to be obtained.

- Store the devices in the foam-lined storage case when not in use.
- Avoid bumping or scratching any part of the mating surfaces.
- Be careful to align the center connectors. Check the alignment carefully before tightening the connector nuts.
- Use a torque wrench for all final connections in order to avoid overtightening.
- Support the devices being used in order to avoid vertical or lateral force on any connectors. This precaution is critical when using the airline, 6 cm "L", or cables.

When Disconnecting Devices:

- Do not rock or bend any connections.
- Pull the connector straight out without unscrewing or twisting.

- Before storage, screw the connector nut all the way out to help protect the surfaces, and use the plastic caps provided. These plastic caps can be taken off easily by unscrewing, rather than pulling.

Caution

Do not use a damaged or defective connector. It will damage any good connector to which it is attached. Throw the connector away or have it repaired.

A connector is bad if it fails either the visual or mechanical examinations or when an experienced operator cannot make repeatable connections. The time and expense involved in replacing four channel test set connectors warrants considerable caution when any connector might be less than perfect.

If any doubts exist about a connector, call your Hewlett-Packard representative. HP field offices offer limited professional advice and have access to the factory for information.

Visual Inspection and Cleaning

Always begin a calibration with a careful visual inspection of the connectors, including the test set connectors to make sure they are clean and undamaged.

Caution

Make sure that you and your equipment are grounded before touching any center conductor so you won't cause static electricity and create a potential for electrostatic discharge. When using or cleaning connectors on the test set, be aware that you are touching exposed center connectors that are connected directly to the internal circuits of the oscilloscope. Touching the center conductor, especially with a wiping or brushing motion, can cause an electrostatic discharge (ESD) and severely damage these sensitive circuits.

Visual Inspection

Use an illuminated, 4-power magnifying glass for visual inspection.

1. Before you begin, make sure you and any equipment you are using are grounded to prevent electrostatic discharge.

2. Examine the connectors first for obvious problems, such as deformed threads, contamination, or corrosion.

3. Next concentrate on the mating surfaces of each connector. Look for scratches, rounded shoulders, misalignment, or any other signs of wear or damage.

4. Make sure that the surfaces are clean, free of dust and solvent residues.

Dirt or damage visible with a 4-power magnifying glass can cause degraded electrical performance and possible connector damage. All connectors should be repaired or discarded immediately.

Cleaning

Cleaning the connectors is seldom necessary. Dust or dirt on the connector surfaces can be brushed or wiped away gently with a plastic foam swab or low-pressure, clean, compressed air. Be sure that you and all of your cleaning equipment are grounded to avoid electrostatic discharge.

If necessary, liquid Freon (trichlorotrifluoroethane), HP part number 8500-1914 CD 7, is the only cleaning solvent recommended by Hewlett-Packard for cleaning 3.5 mm connectors. Several types of liquid Freon exist, so make sure that the kind you use contains only trichlorotrifluoroethane. Some other types contain harmful compounds which can damage precision 3.5 mm connectors. Using the solvent in liquid is preferred because the liquid can be applied sparingly and selectively. If spray must be used, spray the cleaning swab only, not the connector. Use a microscope slide, or similar piece of clear glass to check the solvent periodically for contamination. Refer to figure A4-1.

Caution

Do not, under any circumstances, use abrasives (not even pencil eraser) or any solvent other than trichlorotrifluoroethane. Residue can be left behind that can damage the metal connector surfaces and the plastic conductor supports.

When you are satisfied that all the connectors are clean and undamaged, you can proceed to the mechanical inspection of connector dimensions.

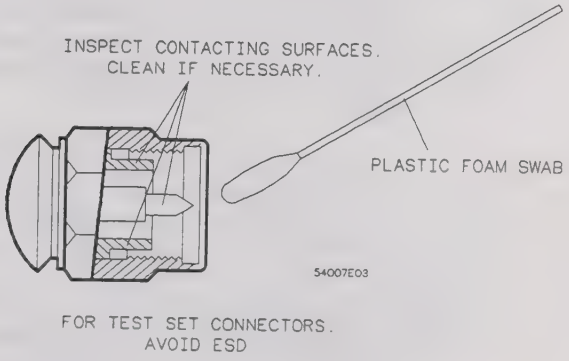


Figure 4A-1. Visual Inspection of APC 3.5 Connectors

Mechanical Inspection

Mechanical inspection of the connectors is the next step. This inspection consists of using the appropriate male or female precision 3.5 mm connector gauge to check the mechanical dimensions of all connectors, including those on the test set. The purpose of doing this is to make sure that perfect mating will occur between the connector surfaces. Perfect mating assures a good electrical match and is very important mechanically to avoid damaging the connectors themselves, especially on the oscilloscope.

Center Conductor

The critical dimension to be measured is the recession of the center conductor. This dimension is shown as MP and FP in Figure A4-2 and A4-3. No protrusion of the center conductor's shoulder is allowable on any connector. The maximum allowable recession of the center conductor shoulder is 0.003 in. (0.08 mm) on all connectors, except those on the four channel test sets.

On the four channel test set connectors, not only is no protrusion allowable, the shoulder of the center conductor must be recessed at least 0.0002 in. (0.005 mm). The maximum allowable recession of the center conductor shoulder on the four channel test set connectors is 0.0021 in. (0.056 mm).

Outer Conductor

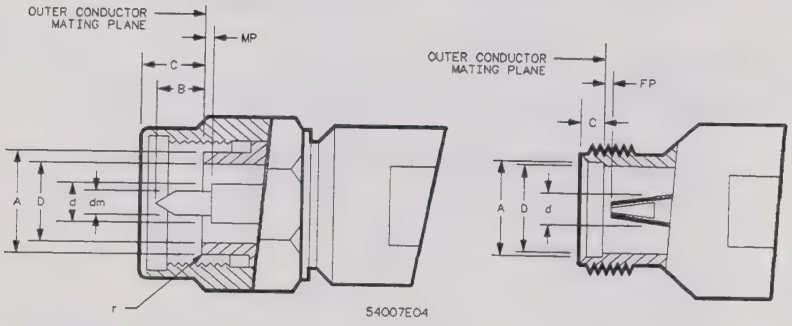
If any contact protrudes beyond the outer conductor mating plane, the contact is out of tolerance and must be replaced. If the center conductor is not recessed at least 0.0002 in. (0.005 mm), it is out of tolerance and must be replaced. In both cases the out-of-tolerance connector will permanently damage any connector attached to it. Destructive electrical interference will also result due to buckling of the female contact fingers. This is often noticeable as a power hole several dB deep occurring at about 22 GHz.

If any contact is recessed too far behind the outer conductor mating plane (0.0021 in. 0.056 mm, except in test sets), poor electrical contact will result, causing high electrical reflections. Careful gauging of all connectors will help prevent this condition.

Before using the connector gauge to measure the connectors, visually inspect the end of the gauge and the calibration block in the same way that you inspected the connectors. Dirty or damaged gauge facings can cause dirty or damaged connectors. Two connector gauges are available from Hewlett-Packard, one for each connector type, male and female. Refer to figure A4-4. A single gauge calibration block is used to zero both gauges; one end protrudes for zeroing the male connector gauge. The part number for both gauges, as well as the calibration block is 85052-80010.

Figures A4-5 to A4-7 show how to use the connector gauges. Zero the gauge with the calibration block. Refer to figure A4-5. It is recommended that you zero both gauges first, then measure each of the terminations and/or adapters that will be used. Then, as the last step, measure the test set connectors.

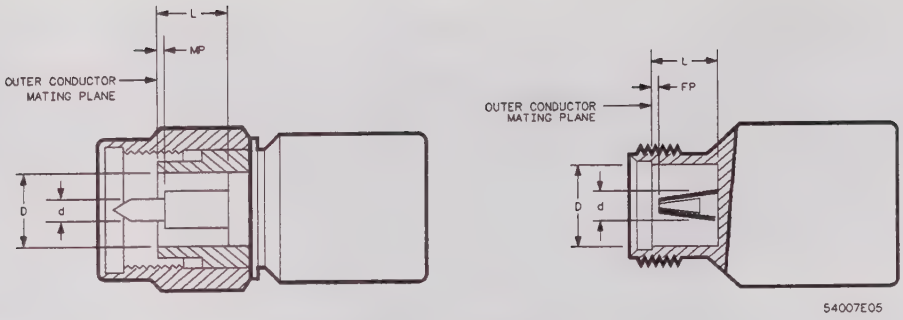
Figures A4-6 and A4-6 show how to measure precision 3.5 mm connectors. Note that a plus (+) reading on the gauge indicates recession of the center conductor and a minus (-) reading indicates protrusion. Since no protrusion of either connector is allowable, readings for connectors within the allowable range will be on the plus (+) scale of the gauge. Also note that the allowable tolerance range for the test set connectors is different from the range for other connectors. Both ranges are shown in Figures A4-6 and A4-7. Before measuring test set connectors, be sure that the power to the test set is off and that you and your equipment are grounded to prevent electrostatic discharge.



D = inside diameter of the outer conductor
d = diameter of male/female center connector
A = outside diameter of outer conductor at the mating plane
r = corner relief for male connector
B = protrusion of the male contact pin tip beyond the outer conductor mating plane
C = recession of the outer conductor mating plane behind outer face of connector
MP = recession of male contact pin shoulder behind outer conductor mating plane
FP = recession of face of female connector behind outer conductor mating plane
Dm = diameter of tip of male contact pin

Male Connectors	Female Connectors	Male Connectors	Female Connectors
D = 0.1378 ± 0.0005 in 3.500 ± 0.013 mm	D = 0.1378 ± 0.0005 in 3.500 ± 0.013 mm	B = $0.085\ ^{+0.005}_{-0.015}$ in $2.16\ ^{+0.13}_{-0.38}$ mm	N/A
d = 0.0598 ± 0.0003 in 1.519 ± 0.008 mm	d = 0.0598 ± 0.0003 in 1.519 ± 0.008 mm	C = 0.120 ± 0.015 in 3.05 ± 0.38 mm	C = 0.176 ± 0.002 in 1.93 ± 0.05 mm
A = $0.1803\ ^{+0.000}_{-0.002}$ in $4.580\ ^{+0.00}_{-0.05}$ mm	A = $0.1807\ ^{+0.002}_{-0.000}$ in $4.590\ ^{+0.05}_{-0.00}$ mm	Mp = $0.000\ ^{+0.003}_{-0.000}$ in $^{+0.08}_{-0.00}$ mm	Fp = $0.000\ ^{+0.003}_{-0.000}$ in $^{+0.08}_{-0.00}$ mm
r = 0.003 in 0.08 mm	r = 0.003 in 0.08 mm	dm = $0.037\ ^{+0.000}_{-0.001}$ in $0.94\ ^{+0.00}_{-0.03}$ mm	N/A

Figure A4-2. Mechanical Dimensions of Connector Faces



D = inside diameter of outer conductor = 0.1378 ± 0.0003 in
3.500 ± 0.008 mm

d = diameter of center conductor = 0.0598 ± 0.0002 in
1.519 ± 0.005 mm

MP = recession of center conductor shoulder = 0.000 + 0.000 / -0.003 in
FP 0.00 + 0.00 / -0.08 mm

L = length of outer conductor = 0.197 ± 0.001 in
0.00 ± 0.000 mm

C = concentricity of contact is governed by mating conector: typically, 0.003 FIM (TIR)

Figure 4A-3. Mechanical Dimensions of the Short Circuit

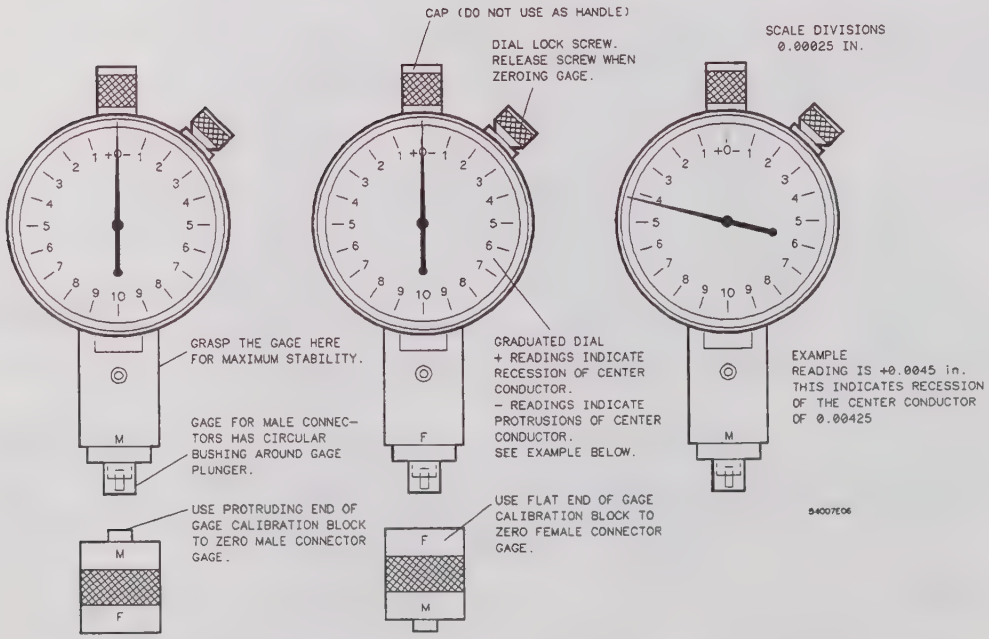


Figure A4-4. Precision 3.5 mm Connector Gages

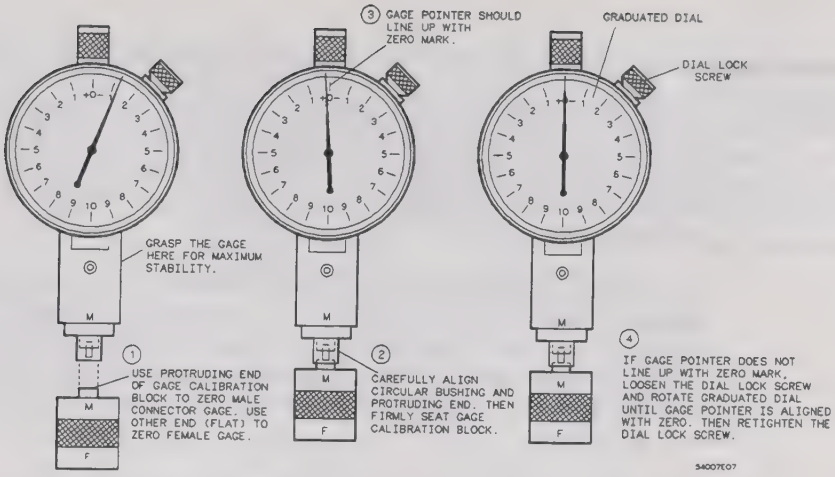

3 GAGE POINTER SHOULD LINE UP WITH ZERO MARK.
GRADUATED DIAL
DIAL LOCK SCREW
GRASP THE GAGE HERE FOR MAXIMUM STABILITY.
1 USE PROTRUDING END OF GAGE CALIBRATION BLOCK TO ZERO MALE CONNECTOR GAGE. USE OTHER END (FLAT) TO ZERO FEMALE GAGE.
2 CAREFULLY ALIGN CIRCULAR BUSHING AND PROTRUDING END. THEN FIRMLY SEAT GAGE CALIBRATION BLOCK.
4 IF GAGE POINTER DOES NOT LINE UP WITH ZERO MARK, LOOSEN THE DIAL LOCK SCREW AND ROTATE GRADUATED DIAL UNTIL GAGE POINTER IS ALIGNED WITH ZERO. THEN RETIGHTEN THE DIAL LOCK SCREW.
M
F
54007E07

Figure A4-5. Zeroing Precision 3.5 mm Connector Gages

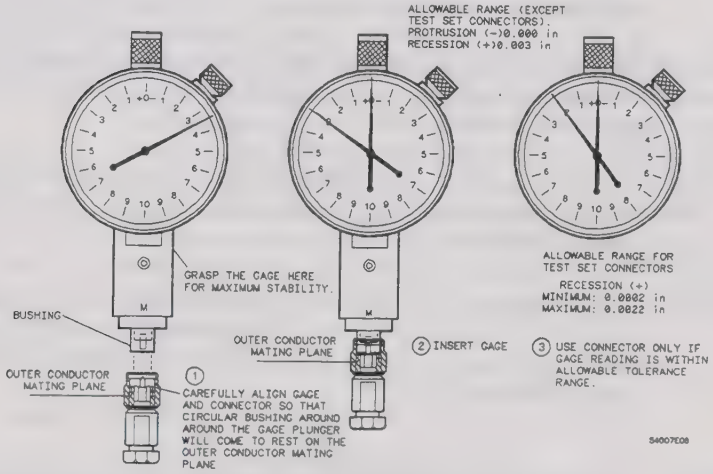

ALLOWABLE RANGE (EXCEPT TEST SET CONNECTORS). PROTRUSION (−)0.000 in RECESSION (+)0.003 in
GRASP THE CAGE HERE FOR MAXIMUM STABILITY.
BUSHING
OUTER CONDUCTOR MATING PLANE
1 CAREFULLY ALIGN GAGE AND CONNECTOR SO THAT CIRCULAR BUSHING AROUND AROUND THE GAGE PLUNGER WILL COME TO REST ON THE OUTER CONDUCTOR MATING PLANE
OUTER CONDUCTOR MATING PLANE
2 INSERT GAGE
3 USE CONNECTOR ONLY IF GAGE READING IS WITHIN ALLOWABLE TOLERANCE RANGE.
ALLOWABLE RANGE FOR TEST SET CONNECTORS
RECESSION (+)
MINIMUM: 0.0002 in
MAXIMUM: 0.0022 in
54007E08

Figure A4-6. Measuring Precision 3.5 mm Male Connectors

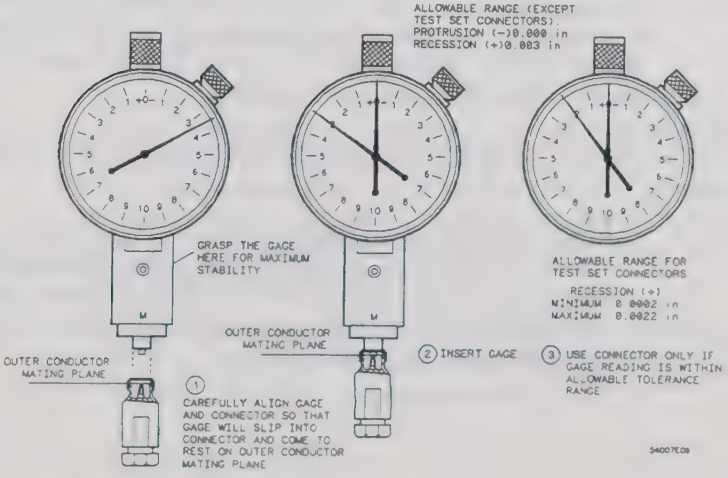

ALLOWABLE RANGE (EXCEPT TEST SET CONNECTORS). PROTRUSION (−)0.000 in RECESSION (+)0.003 in
GRASP THE GAGE HERE FOR MAXIMUM STABILITY
OUTER CONDUCTOR MATING PLANE
1 CAREFULLY ALIGN GAGE AND CONNECTOR SO THAT GAGE WILL SLIP INTO CONNECTOR AND COME TO REST ON OUTER CONDUCTOR MATING PLANE
OUTER CONDUCTOR MATING PLANE
2 INSERT GAGE
3 USE CONNECTOR ONLY IF GAGE READING IS WITHIN ALLOWABLE TOLERANCE RANGE
ALLOWABLE RANGE FOR TEST SET CONNECTORS
RECESSION (+)
MINIMUM 0.0002 in
MAXIMUM 0.0022 in
54007E09

Figure A4-7. Measuring Precision 3.5 mm Female Connectors

Connecting the Devices

Figures A4-8 and A4-9 illustrate the Hewlett-Packard recommended procedures for making connections with the calibration devices. Notice that these recommended procedures differ from traditional procedures used in the microwave industry, especially the counter-rotation technique and procedure for connecting the airline.

The counter-rotation technique, recommended here, involves a slight rotation of the termination or adapter just before the final tightening of the connector nut. This eliminates the very small air wedge between the outer conductors that frequently occurs when the body is held stationary during tightening, as it is in the traditional procedure. The HP 54120 system will detect the reflections caused by such small wedges.

The counter-rotation technique does not harm the connectors. The gold plating on the outer conductor surface will become burnished in time. This is normal, and as long as the surface remains smooth, the connector is still good. After much use the gold plating may eventually wear through and expose the beryllium-copper substratum. This too is normal, and if it is smooth the connector is still good, although the beryllium-copper surface may oxidize if the connector is used infrequently.

If the burnished surface is rough, scratched, rippled, or has other irregularities, too much tightening force is being used. If the roughness is severe, the connector is ruined and should not be used.

Caution

Damage can result if SMA connectors are overtightened to precision 3.5 mm connectors. Use a torque wrench designed for SMA connectors, set to a 5 in lb (60 N/cm). A torque wrench suitable for SMA connectors is available, HP part number 8710-1582.

Counter-Rotation Technique

The recommended Hewlett-Packard counter-rotation technique is for precision 3.5 mm connectors. Before making any connections to the test set, ground yourself with a grounded wrist strap. Also, it is good practice to grasp the outer shell of the test port before you make any connections to the test set in order to discharge any static electricity on your body. This is the most effective single safeguard to prevent ESD damage to your instruments.

Connect 3.5 mm devices by the following procedure. Refer to figures A4-8 and A4-9.

1. If the device has a retractable connector nut, fully retract the nut before mating the connectors. Carefully align the male and female contact pins and slide the connectors straight together until the center and the two outer conductors meet. Be careful not to twist or bend the contact pins. You should feel a slight resistance as the connectors mate.

2. Make the preliminary connection by attaching the connector nut of the male connector to the female. The male connector is held stationary as the female connector is tightened and draws the male pin into the female connector. Refer to figure 4A-8. Any other method used may cause the male pin to damage the female connector. Support the body of the device and turn the connector nut until the mating surfaces make light contact. Do not overtighten. All you want is a connection of the outer conductors with gentle contact at all points of both mating surfaces.

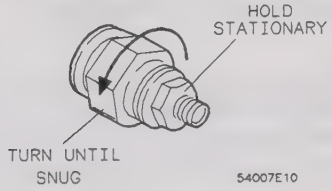


Figure A4-8. Connecting Devices

3. When you are satisfied with this preliminary connection, use the following counter-rotation technique to eliminate air wedges between the mating planes. Refer to figure A4-9. If the calibration device is male, hold the connector nut firmly. Very slowly rotate the body of the device about 10-20° counterclockwise. Note that this slight rotation or backwiping is sufficient. Greater rotation does not improve electrical performance and increases wear on the connector surfaces. If the calibration device is female (the connector nut is on the test set), very slowly rotate both the connector nut and the body of the device clockwise 10-20° (counterclockwise rotation will loosen the connection).

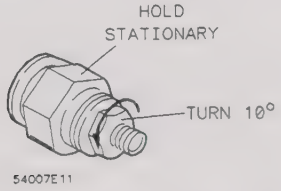


Figure 4A-9. Counter Rotation Technique

Light, smooth frictional resistance felt during the counter-rotation indicates you have made the preliminary connection correctly and that the counter-rotation technique has been successful. Roughness felt during counter-rotation indicates either that the connectors are damaged or that there is roughness in the connector nut/thread contact. Inspect both connectors again before proceeding, to make sure that the roughness is due to roughness in the connector nut interface rather than on the connector mating planes.

4. Tighten the connector nut finger tight, allowing the device to turn with the nut if it tends to do so. A small rotation of the body of the device at this point is acceptable and tends to occur naturally.

5. Use a torque wrench to make the final connection. Use of the torque wrench assures the final connection will be tight enough for optimum electrical performance, but not so tight as to distort or damage the connectors. Refer to pages A1-2.

To disconnect, follow this procedure:

1. Loosen the connector nut on the male connector with the torque wrench. Leave the connection finger tight.

2. While supporting the calibration device, gently unfasten the connectors and pull the calibration device straight out of the test port connector. Do not twist either the center conductor or the outer conductor housing or exert lateral or vertical (bending) force on the connection.

Note that some precision 3.5 mm female connector fingers are very tight and can pull the center pin of their mates out past specifications as they are disconnected. If such a male pin is inserted into a female connector it can cause considerable damage by pushing the female center conductor back too far. Be aware of this possibility and check all connectors before mating them again.

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October 1992

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5959-6031

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